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Incremental Contribution of the Minnesota Multiphasic Personality Inventory – 3 to Predicting One-Year Postoperative Spinal Cord Surgery/Spinal Cord Stimulation Outcomes

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Abstract

Pre-surgical psychological assessments are becoming common in the United States and are recommended or required prior to surgical/spinal cord stimulator intervention for chronic back pain. Psychological testing is often recommended for these evaluations and the various versions of the Minnesota Multiphasic Personality Inventory (MMPI) have demonstrated utility for predicting outcomes in this setting. This investigation sought to extend that literature with the newest version of the MMPI, the MMPI-3. The sample comprised of 909 patients (50.5% men, 49.5% women) who consented to participating in an outcome study and took the MMPI-3 along with other self-report measures of pain, functional disability, and emotional functioning prior to surgery as part of their pre-surgical psychological assessment. Self-report measures of pain, functional disability, and emotional functioning were administered again one-year following the intervention. MMPI-3 scale scores accounted for up to 9% of additional variance in the outcomes after controlling for pre-surgical measures. Measures of emotional/internalizing dysfunction, somatic dysfunction, and, to a lesser extent, behavioral/externalizing dysfunction contributed the most to the prediction of poorer outcomes.

Keywords MMPI-3 · Spine surgery · Spinal cord stimulator · Outcome · Back pain

Back pain is a common occurrence in the United States – with upward of 80% of the population having experienced various forms of chronic low back pain (Freburger et al., 2009; Patrick et al., 2014; Rubin, 2007). Though surgery is not the primary treatment for back pain, a portion of patients seek surgical intervention to alleviate their symptoms – despite growing evidence of post-operative complications and unfavorable outcomes for spine surgeries (e.g., lumbar discectomy and spinal fusion) (Murray et al., 2023; Soroceanu et al., 2012). Surgery can be efficacious in the treatment of back pain, but patients undergoing surgical operations of the spine may be subject to complications during, immediately after, or long-term post-operation. Some of the complications patients face include: failure to relieve pain, nerve injury, vascular injury, myocardial infarction, and stroke (Swann et al., 2016). Indeed, one study found that 28% of patients who underwent a spinal operation reported unfavorable outcomes and 10% of patients needed to undergo a reoperation (Copay et al., 2010).

A substantial body of research indicates that psychosocial characteristics can attenuate good outcomes following spine surgery (Block et al., 2013; Marek et al., 2021; Murray et al., 2023). For instance, pre-surgical depression has been associated with poorer results and lower levels of satisfaction following surgery (Adogwa et al., 2012; Block et al., 2001; Chaichana et al., 2011; Herron et al., 1992; Marek et al., 2019). Anxiety and various indices of somatoform psychopathology have also been associated with poorer

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outcomes among patients who have obtained spine surgery (Chaichana et al., 2011; Marek et al., 2015, 2021). Other psychosocial factors such as catastrophizing, fear and avoidance beliefs, substance abuse, litigation, and workers' compensation have also been associated with adverse outcomes (Block et al., 2014; Carreon et al., 2010; den Boer et al., 2006a; den Boer, Oostendorp, Beems, Munneke, Oerlemans et al., 2006b; LaCaille et al., 2007; Mannion and Elfering, 2006; Menendez et al., 2015).

Guided by evidence that pre-surgical psychosocial factors can predict diminished outcomes, the practice of pre-surgical psychological assessment has been increasing in the United States to help the surgical team identify whether psychosocial risk factors are present and, if so, to what extent they may contribute to a diminished outcome (Marek & Block, 2023a). Once risk is determined, the mental health provider aids the team in identifying pre-surgical and/or post-surgical intervention for the patient to help them achieve optimal outcome.

Psychological testing is recommended to be incorporated in pre-surgical psychological evaluations (Block & Marek, 2020; Marek & Block, 2023b). The various versions of the Minnesota Multiphasic Personality Inventory (MMPI) have commonly been used in these assessments. Historically, higher scores on MMPI (Hathaway & McKinley, 1943) and MMPI-2 (Butcher et al., 1989; Butcher et al., 2001) clinical scales of Depression, Psychasthenia, Hypochondriasis, and Hysteria have been associated with poorer outcomes in patients seeking spine surgery across various samples (Block et al., 2001; den Boer, Oostendorp, Beems, Munneke, Oerlemans et al., 2006b; Herron et al., 1992; Schocket et al., 2008; Spengler et al., 1990; Trief et al., 2000). Extensive research with the MMPI-2-Restructured Form (MMPI-2-RF) (Ben-Porath & Tellegen, 2008/2011; Tellegen & Ben-Porath, 2008/2011), which was designed to address psychometric shortcomings of the MMPI and MMPI-2, documented associations between presurgical scores and adverse outcomes in spine surgery patients.

The MMPI-2-RF scale scores yielded good psychometric properties when used with patients seeking spine surgery and spinal cord stimulation (Block & Ben-Porath, 2018). The test's scores have demonstrated good reliability and converge and discriminant well with pre-surgical criteria and constructs (Block et al., 2013; Kenfack et al., 2022; Marek et al., 2020b). When predicting outcomes, the scale scores of the MMPI-2-RF have predicted both shorter-term (approximately 3 months postoperative) and longer-term (one-year postoperative) outcomes (Block et al., 2017; Marek et al., 2015, 2019, 2021).

Recently, the MMPI-3 (Ben-Porath & Tellegen, 2020a, b) was developed to refine some existing scales on the MMPI-2-RF, modernize item content, introduce new items, create new scales that cover domains not present in the MMPI-2-RF item pool (such as Eating Concerns, Compulsivity, Impulsivity, and Self-Importance), and incorporate updated normative data consistent with the 2020 census. Many scales from the MMPI-2-RF that were refined and carried over for the MMPI-3 have demonstrated equivalence pertaining to their validity (Ben-Porath & Tellegen, 2020b; Hall et al., 2021). In a pre-surgical sample of patients seeking spine surgery (Marek et al., 2022), MMPI-3 scales produced good reliability coefficients and good convergent and discriminant validity with criteria that comprised of data from other self-report measures and that were derived from a concurrently conducted clinical interview.

The purpose of this study is to begin to establish the ability of MMPI-3 scale scores predict one-year outcomes following spine surgery or spinal cord stimulation. In a past study using the MMPI-2-RF scale scores to predict 3-month outcomes after controlling for associated pre-surgical criteria, MMPI-2-RF scores accounted for an additional 2-11% of the variability in outcomes after controlling for associated pre-surgical criteria (Marek et al., 2015). It was hypothesized that the MMPI-3 scale scores will yield similar incrementally predictive value in a sample of patients who have obtained spine surgery or a spinal cord stimulation.

Method

Participants

A total of 915 patients who were seeking spine surgery or a spinal cord stimulator who consented to be part of an outcome study, completed the MMPI-3, and had collateral chart review data available were initially included in the study. All patients completed a pre-surgical psychological evaluation that included a medical record review, a clinical interview, the MMPI-3, and several other self-report measures that were administered during the preoperative evaluation and again one-year after surgery. Of those, 6 patients produced an invalid MMPI-3 protocol using criteria outlined in the MMPI-3 Technical Manual (Ben-Porath & Tellegen, 2020b): Cannot Say (CNS) $\geq$ 15, Combined Response Inconsistency (CRIN) $\geq$ 80T, Variable Response Inconsistency (VRIN) $\geq$ 80T, True Response Inconsistency (TRIN) $\geq$ 80T, Infrequent Responses (F) = 100T, and Infrequent Psychopathology Responses (Fp) $\geq$ 100T. Of the 909 patients remaining, 50.5% were men (n = 459) and 49.5 were women (n = 450). The sample was predominantly White (82.8%) and a smaller percentage were Black (4.1%), multiracial (3.0%) or were of another race (10.1%). The mean age of the sample was 51.33 years old (SD = 13.71). It is also important to report that 34.2% of the sample elevated

the under-reporting scale Uncommon Virtues and 21.1% of the sample elevated under-reporting scale Adjustment Validity. Additionally, only those who obtained surgery were included in the current study. A total of 42% were deemed excellent candidates and 37.8% were considered good candidates though some post-operative psychological treatment was recommended to them. A total of 16.7% were deemed fair candidates, had numerous risk factors, and were likely required to have some pre or postoperative psychological intervention. The rest (3.5%) were deemed poor or very poor candidates, but likely received the surgery because the team felt surgical intervention outweighed the risk factors. A total of 15% of the sample reported having had previous outpatient or short-term psychotherapy and 17.5% reported having been an inpatient for psychiatric reasons or receiving long-term psychotherapy. 15.8% of the sample reported having had at least one prior pain procedure. Surgical procedures the patients were evaluated for are listed in Table 1.

Of the total sample, 214 patients responded to an outcome survey that was emailed to them approximately one-year following their procedure along with a few reminders for those who did not respond. Higher pre-surgical scale scores on the Somatic Complaints ($r = .11$, $p = < 0.001$) and Neurologic Complaints ($r = .11$, $p = < 0.001$) scales were found among non-responders to the one-year follow-up survey. No other demographic or pre-surgical measures predicted non-response at the one-year follow-up.

Use of these data was approved by the last author's Institutional Review Board. Although these data are not preregistered, data can be made available for replication purposes providing appropriate institutional agreements are met.

Measures

Minnesota Multiphasic Personality Inventory – 3 (MMPI-3) (Ben-Porath and Tellegen, 2020a, b)

The MMPI-3 is a 335-item, self-report inventory that assesses a broad range of psychopathology and personality. The test contains 10 validity scales measuring inconsistent, over-reporting, and under-reporting response styles in addition to 42 substantive scales assessing emotional, behavioral, thought, interpersonal, and somatic/cognitive dysfunction. The scale scores yield good reliability and validity in spine surgery and spinal cord stimulator seeking samples (Marek et al., 2022). Only the Emotional/Internalizing Dysfunction, Behavioral/Externalizing Dysfunction, and Somatic/Cognitive Complaint scales were used in this study because these sets of scales have demonstrated the best predictive power on the previous version of the test (Block et al., 2017; Marek et al., 2015).

MMPI-3 scale scores were derived from an administration of the MMPI-2-RF-Expanded (MMPI-2-RF-EX) for 845 patients in this sample. The MMPI-2-RF-EX was an expanded version of the MMPI-2-RF used to develop the MMPI-3. All 338 MMPI-2-RF items (with some revisions) and an additional 95 trial items written for the MMPI-3 were included. MMPI-3 scales scored from the MMPI-2-RF-EX are comparable to scores obtained by MMPI-3 administration (Hall et al., 2021). The rest of the sample (n = 64; 7%) took the MMPI-3 and there were no statistically significant differences between groups on MMPI-3 substantive scale scores between those that took the MMPI-2-RF-EX and those who took the MMPI-3.

Table 1 Spine Interventions Patients Received (n = 909)

Type of Surgery	Percent
Fusion	49.70
Laminectomy/Discectomy/Decompression	2.40
TDR Disc Replacement	26.30
Hybrid (combined TDR and fusion)	0.30
Hardware Removal	0.10
SCS	7.70
Narcotic Pain	0.10
Discogram/Discography Disc Stimulation	1.80
Unknown	11.60
Total	100.00

Oswestry Disability Index (ODI) (Fairbank and Pynsent, 2000)

The ODI is a 10-item, self-report measure that assesses functional disability. The overall score represents the percentage of functional disability (0-100%) that the patient is reporting. The overall index score (0-100% functional disability) yields good reliability and validity in both chronic pain and spine surgery seeking samples (Block et al., 2013; Fairbank & Pynsent, 2000; Kopec et al., 1996; Marek et al., 2015; Pratt et al., 2002). In the current sample, internal consistency was good when assessed pre-surgically ($\alpha = 0.84$) and at the one-year follow-up ($\alpha = 0.89$).

Pain and Spine Surgery Survey (PASSS) (Marek et al., 2015)

The PASSS is a self-report measure that assessed patients' self-reported pain level, pain interference with their lifestyle, and current emotional states all via single item Likert-style responses. Pain and pain interference with lifestyle questions were scored on a 0- to 10-point Likert-type scale, with a higher value indicating more pain and more lifestyle interference. The intensity of emotions (depressed, nervous, anger, irritability, fear, and worry) were scored on a 1–5 point Likert-type scale, with 1 indicating 'not at all' to 5 indicating 'extreme'.

Procedure

Patients underwent a standardized pre-surgical psychological evaluation that included psychological testing, a clinical interview, and a medical record review (Block & Marek, 2020; Marek & Block, 2023b). This included the MMPI-3, the ODI, and the PASSS. Patients were asked if they were interested in being part of an outcome study and provided informed consent if they expressed interest. Patients were emailed a Qualtrics link that contained the PASSS and the ODI around their one-year postoperative date.

A paired samples t-test was calculated using the ODI and PASSS score differences between the pre-surgical and postoperative time points (Table 2). Cohen's d effect sizes were also reported, with 0.20 being considered a small effect, 0.50 being considered a modest effect, and 0.80 being considered a large effect. Descriptive statistics and % elevated for this sample on MMPI-3 substantive scales are reported in Table 3. Pearson product-moment correlation coefficients were calculated between the MMPI-3 substantive scale scores used in this study and the ODI and the PASSS at both the presurgical time point (Table 4) and postsurgical time point (Table 5). Pre-surgical PASSS and ODI scores were also correlated with post-surgical criteria in Table 5. Given the large number of correlations calculated and consideration for Type I error, only coefficients that were statistically significant and reached a threshold of 0.20 were considered. A 0.20 threshold for correlation coefficients was determined based on updated effect size guidelines that denote 0.20 to be equivalent to a modest effect size and would be considered clinically meaningful (Funder & Ozer, 2019).

Hierarchical regression analyses using the PASSS and ODI as dependent variables were then calculated. The purpose of the hierarchical regression analyses was to determine the incremental predictive power of the MMPI-3 scale scores to prediction of one-year outcomes after controlling for the dependent variables associated pre-surgical score. Each dependent variable's pre-surgical score was entered into the first step of the model. MMPI-3 scale scores were entered into the second step of the model via a stepwise fashion by scale set (i.e., High-Order, Restructured Clinical, PSY-5, etc.) if the scales were meaningfully associated with the criteria. Entering scales by scale set eliminates multicollinearity that would otherwise occur if all scales were entered into the model due to item-overlap across scale sets. A stepwise method was used in the second step to understand which scales within each scale set yields the strongest predictive values without compromising statistical power or inflating R^2.

Results

Listed in Table 2 are means, standard deviations, and results of paired-samples t-tests of presurgical and postsurgical criteria. Pain levels, pain interference with lifestyle, and ODI scores significantly and substantially decreased one-year following spine surgery. Nervousness, fearfulness, and feeling worried also significantly decreased one-year following spine surgery, but at a smaller magnitude. Feelings of depression, anger, and irritability did not statistically change one-year following spine surgery. Listed in Table 3 are descriptive statistics and % elevated for this sample on MMPI-3 substantive scales for the sample. Generally speaking, psychopathology was often present in the pre-surgical sample despite all these participants being cleared for surgery and the level of under-reporting in this sample.

Displayed in Table 4 are Pearson product-moment correlations between pre-surgical criteria and MMPI-3 scale scores. Pre-surgical pain levels were positively and modestly associated with higher scores on the Malaise scale. Higher scores on Emotional/Internalizing Dysfunction,

Table 2 Paired-Samples *t*-test between Pre-Surgical and Post-Surgical Criteria

Criteria	Presurgical Score		Postoperative Score		Dependent Samples *t* test		
	M	*SD*	*M*	*SD*	*t* (df)	*p*	Cohen's *d*
Current pain level (n = 214)	7.22	1.91	3.44	2.38	19.24 (213)	< 0.001	1.32
Pain-related interference with lifestyle (n = 214)	8.38	2.06	3.65	2.7	21.89 (213)	< 0.001	1.50
Oswestry Disability Index (n = 183)	62.05	14.10	39.76	17.64	16.86 (182)	< 0.001	1.25
Depressed (n = 214)	1.67	0.91	1.69	0.92	0.36 (213)	0.723	0.02
Nervous (n = 214)	2.16	0.86	1.70	0.95	6.11 (213)	< 0.001	0.42
Angry (n = 214)	1.37	0.70	1.42	0.76	0.76 (213)	0.447	0.05
Irritable (n = 214)	1.79	0.84	1.63	0.76	2.41 (213)	0.017	0.17
Fearful (n = 214)	1.85	0.80	1.59	0.84	3.51 (213)	< 0.001	0.24
Worried (n = 214)	2.14	0.90	1.85	0.92	3.74 (213)	< 0.001	0.26

Note: Pain and pain interference with lifestyle questions were scored on a 0- to 10-point Likert-type scale, with a higher value indicating more pain and more lifestyle interference. Oswestry Disability Index scores represent the percentage of functional disability (0-100%) that the patient is reporting. The intensity of emotions (depressed, nervous, anger, irritability, fear, and worry) were scored on a 1–5 point Likert-type scale, with 1 indicating 'not at all' to 5 indicating 'extreme'

Table 3 Descriptive Statistics and Percent Elevated Cut-Offs for MMPI-3 Substantive Scales (n = 909)

	% Elevated	Descriptive Statistics	
		M	SD
Higher-Order			
Emotional/Internalizing Dysfunction	3.2	45	8
Thought Dysfunction	0.4	44	7
Behavioral/Externalizing Dysfunction	1.2	45	8
Restructured Clinical			
Demoralization	3.4	43	8
Somatic Complaints	11.3	52	9
Low Positive Emotions	5.9	47	9
Antisocial Behavior	1.2	45	8
Ideas of Persecution	0.6	44	7
Dysfunctional Negative Emotions	3.7	44	8
Aberrant Experiences	0.7	44	7
Hypomanic Activation	2.6	45	8
Somatic-Cognitive Specific Problems Scales			
Malaise	15.8	50	11
Neurological Complaints	16.7	52	11
Eating Concerns	2.5	46	6
Cognitive Complaints	6.3	46	9
Internalizing Specific Problems Scales			
Suicidal/Death Ideation	7.8	46	5
Helplessness/Hopelessness	3.3	45	7
Self Doubt	3.7	45	7
Inefficacy	2.0	43	7
Stress	5.2	46	8
Worry	7.6	44	8
Compulsivity	5.0	48	9
Anxiety Related Experiences	3.2	44	8
Anger Proneness	4.8	46	9
Behavior Restricting Fears	1.0	46	6
Externalizing Specific Problems Scales			
Family Problems	3.5	43	8
Juvenile Conduct Problems	3.3	47	9
Substance Abuse	1.7	45	7
Impulsivity	4.0	46	8
Activation	3.2	45	8
Aggression	2.2	47	9
Cynicism	2.5	44	8
Interpersonal Specific Problems Scales			
Self-Importance	5.0	51	10
Dominance	9.6	50	10
Disaffiliativeness	3.2	45	8
Social Avoidance	9.9	49	9
Shyness	4.7	46	8
Personality Psychopathology-5			
Aggressiveness	2.9	49	8
Psychoticism	0.4	44	7
Disconstraint	1.0	46	7
Negative Emotionality/Neuroticism	2.5	44	8
Introversion/Low Positive Emotionality	10.9	50	9

Demoralization, Somatic Complaints, Malaise, Neurological Complaints, and Self-Doubt were significantly and modestly associated with higher pain interference with lifestyle. A similar pattern was observed when using the ODI as the criterion. Numerous associations between the MMPI-3 scale scores and emotional likert items on the PASSS were observed and demonstrated a strong convergent pattern. Depression scores correlated the highest with on the MMPI-3 measures of internalizing dysfunction such as Emotional/Internalizing Dysfunction, Demoralization, and Negative Emotionality/Neuroticism. Similarly, some of the highest statistically significant correlations with Nervousness included Emotional/Internalizing Dysfunction, Demoralization, Dysfunctional Negative Emotions, Anxiety-Related Experiences, and Negative Emotionality/Neuroticism. Emotional/Internalizing Dysfunction, Demoralization, and Anger Proneness were significantly correlated the highest with anger and irritability scores. Emotional/Internalizing Dysfunction, Demoralization, Dysfunctional Negative Emotions, Stress, Worry, Anxiety-Related Experiences, and Negative Emotionality/Neuroticism all significantly correlated the highest with Fearful and Worried scores.

Displayed in Table 5 are Pearson product-moment correlations between one-year post-surgical criteria and pre-surgical ODI, PASSS items, and MMPI-3 scale scores. Higher ODI scale scores prior to surgery were modestly to substantially correlated with post-surgical ODI and Current Pain Interference with Lifestyle one year after surgery. Positive presurgical depression scores with all post-surgical emotional likert items from the PASSS were modestly to substantially correlated. There were positive and significant correlations between pre-surgical nervousness and post-surgical nervousness and fear that were deemed to be modest. Pre-surgical anger was positively and modestly associated with post-surgical anger and irritability. Last, pre-surgical irritability was modestly and positively associated with post-surgical depression, nervousness, anger, and irritability.

Regarding pre-surgical MMPI-3 scale scores and post-surgical criteria, higher post-surgical pain levels were modestly and significantly associated with higher scale scores on Somatic Complaints and Neurological Complaints. Higher scale scores on Somatic Complaints, Malaise, and Neurological Complaints were modestly and significantly correlated with greater pain interference with lifestyle and ODI scale scores after surgery. Postoperative depression scores correlated the highest with MMPI-3 internalizing scales including Emotional/Internalizing Dysfunction, Demoralization, and Negative Emotionality/Neuroticism. Some of the highest statistically significant correlations with Nervousness included Worry, Anxiety-Related Experiences, and Negative Emotionality/Neuroticism. Behavioral/

Externalizing Dysfunction, Antisocial Behaviors, Juvenile Conduct Problems, and Disconstraint were significantly correlated the highest with anger. Higher irritability scores were most strongly and significantly correlated with higher Demoralization, Worry, Anxiety Related Experiences, and Negative Emotionality/Neuroticism scores. Worry, Anxiety-Related Experiences, and Negative Emotionality/Neuroticism scores all significantly correlated with Fearful scores. Last, higher criterion Worried scores were most highly correlated with MMPI-3 Worry scale scores.

Results of the hierarchical regression analyses using the PASSS and ODI as dependent variables are listed in Table 6. Each dependent variable's pre-surgical score was entered into the first step of the model. MMPI-3 scale scores were entered into the second step of the model via a stepwise fashion by scale set (i.e., High-Order, Restructured Clinical, PSY-5, etc.) if the scales were meaningfully associated with the criteria presented in Tables 4 and 5. Pre-surgical pain levels accounted for 1% of the variance in post-operative pain levels. Once controlled for, MMPI-3 scales Somatic Complaints and Neurological Complaints accounted for an additional 4% of the variance in post-operative pain levels. A total of 1% of the variance was accounted in post-surgical pain-related interference with lifestyle by its associated pre-surgical scores. Up to 5% of additional variance in post-surgical pain-related interference with lifestyle was accounted for by MMPI-3 scale scores on Somatic Complaints and Neurological Complaints. When examining post-operative ODI score, pre-surgical ODI scores accounted for 15% of the variance in post-operative scores. MMPI-3 scales Somatic

Table 4 Correlations between Pre-Surgical MMPI-3 Scale Scores and Pre-Surgical External Criteria

MMPI-3 Scales	Current Pain Level (n = 872)	Current Pain Interference with Lifestyle (n = 872)	Oswestry Disability Index (n = 905)
Emotional/Internalizing Dysfunction	0.10**	**0.21****	**0.22****
Behavioral/Externalizing Dysfunction	0.02	0.10**	0.03
Demoralization	0.07*	**0.20****	**0.21****
Somatic Complaints	0.18**	**0.25****	**0.34****
Low Positive Emotions	0.03	0.08**	0.13**
Antisocial Behavior	0.03	0.08**	0.05
Dysfunctional Negative Emotions	0.08**	0.15**	0.16**
Hypomanic Activation	0.02	0.07*	0.01
Malaise	**0.24****	**0.36****	**0.42****
Neurological Complaints	0.15**	**0.24****	**0.35****
Eating Concerns	0.01	0.06*	0.06*
Cognitive Complaints	0.08**	0.15**	**0.21****
Suicidal/Death Ideation	0.00	0.10**	0.07*
Helplessness/Hopelessness	0.06	0.13**	0.14**
Self Doubt	0.04	**0.20****	**0.20****
Inefficacy	0.04	0.08*	0.13**
Stress	0.10**	0.16**	0.15**
Worry	0.06*	0.15**	0.13**
Compulsivity	0.04	0.06*	0.03
Anxiety Related Experiences	0.06*	0.17**	0.18**
Anger Proneness	0.06*	0.12**	0.09**
Behavior Restricting Fears	0.12**	0.10**	0.13**
Family Problems	0.07*	0.09**	0.12**
Juvenile Conduct Problems	0.00	0.03	0.02
Substance Abuse	0.01	0.05	−0.03
Impulsivity	0.03	0.12**	0.07*
Activation	0.06*	0.03	0.06*
Aggression	0.04	0.08**	0.02
Cynicism	0.12**	0.06*	0.08**
Aggressiveness	0.04	0.06*	−0.02
Disconstraint	0.01	0.09**	0.01
Negative Emotionality/Neuroticism	0.08**	0.18**	0.17**
Introversion/Low Positive Emotionality	0.01	0.06*	0.10**

Note. Correlations are bolded if they yielded a small to medium effect size and were statistically significant at $p < .05$; *indicates $p < .05$; ** indicates $p < .01$

Table 4 (Continued) Correlations between Pre-Surgical MMPI-3 Scale Scores and Pre-Surgical External Criteria

MMPI-3 Scales	Depressed (n = 872)	Nervous (n = 872)	Anger (n = 872)	Irritable (n = 872)	Fearful (n = 872)	Worried (n = 872)
Emotional/Internalizing Dysfunction	**0.61****	**0.51****	**0.44****	**0.40****	**0.39****	**0.45****
Behavioral/Externalizing Dysfunction	**0.20****	0.18**	**0.24****	**0.24****	0.13**	0.19**
Demoralization	**0.61****	**0.49****	**0.42****	**0.37****	**0.37****	**0.43****
Somatic Complaints	**0.38****	**0.35****	**0.27****	**0.26****	**0.23****	**0.27****
Low Positive Emotions	**0.36****	**0.26****	**0.24****	0.18**	0.18**	**0.20****
Antisocial Behavior	**0.21****	0.16**	**0.22****	**0.22****	0.14**	0.18**
Dysfunctional Negative Emotions	**0.45****	**0.45****	**0.39****	**0.39****	**0.38****	**0.42****
Hypomanic Activation	0.15**	0.18**	0.19**	0.16**	0.14**	0.17**
Malaise	**0.45****	**0.34****	**0.34****	**0.29****	**0.27****	**0.29****
Neurological Complaints	**0.31****	**0.28****	**0.23****	**0.23****	0.18**	**0.20****
Eating Concerns	0.16**	0.14**	0.15**	0.11**	0.12**	0.12**
Cognitive Complaints	**0.38****	**0.34****	**0.24****	**0.27****	**0.20****	**0.25****
Suicidal/Death Ideation	**0.30****	0.17**	**0.26****	**0.24****	0.19**	0.14**
Helplessness/Hopelessness	**0.33****	**0.27****	**0.24****	0.19**	**0.21****	**0.22****
Self Doubt	**0.49****	**0.39****	**0.31****	**0.26****	**0.32****	**0.34****
Inefficacy	**0.34****	**0.37****	**0.26****	**0.22****	**0.27****	**0.33****
Stress	**0.43****	**0.49****	**0.32****	**0.31****	**0.38****	**0.44****
Worry	**0.45****	**0.47****	**0.34****	**0.32****	**0.39****	**0.47****
Compulsivity	0.20**	0.19**	0.19**	0.19**	0.23**	0.24**
Anxiety Related Experiences	**0.51****	**0.52****	**0.37****	**0.34****	**0.40****	**0.44****
Anger Proneness	**0.35****	**0.32****	**0.41****	**0.42****	**0.24****	**0.27****
Behavior Restricting Fears	**0.20****	**0.22****	0.12**	0.10**	0.18**	0.17**
Family Problems	**0.31****	**0.28****	**0.31****	**0.26****	**0.25****	**0.29****
Juvenile Conduct Problems	0.10**	0.07*	0.13**	0.14**	0.06*	0.09**
Substance Abuse	**0.24****	0.19**	**0.21****	**0.21****	0.16**	0.18**
Impulsivity	0.19**	**0.21****	**0.22****	0.19**	0.15**	0.19**
Activation	0.12**	0.15**	0.12**	0.10**	0.15**	0.15**
Aggression	0.18**	0.16**	**0.33****	**0.30****	0.15**	**0.21****
Cynicism	**0.21****	0.15**	**0.22****	0.18**	0.13**	**0.21****
Aggressiveness	0.01	−0.02	0.14**	0.14**	−0.02	0.02
Disconstraint	0.19**	0.17**	**0.22****	**0.21****	0.12**	0.15**
Negative Emotionality/Neuroticism	**0.50****	**0.55****	**0.37****	**0.35****	**0.42****	**0.49****
Introversion/Low Positive Emotionality	**0.30****	0.17**	0.19**	0.16**	0.13**	0.11**

Note. Correlations are bolded if they yielded a small to medium effect size and were statistically significant at $p < .05$; *indicates $p < .05$; ** indicates $p < .01$

Complaints, Malaise, and Neurological Complaints added up to an additional 6% of explained variance in post-operative ODI scores. Pre-surgical Depression scores accounted for 20% of the variance in post-surgical depression scores. MMPI-3 scales Emotional/Internalizing Dysfunction, Demoralization, Low Positive Emotions, Suicidal/Death Ideation, Worry, and Disconstraint accounted for up to 7% of additional variance in post-operative depression scores. Pre-operative Nervous scores accounted for 8% of the variability in post-operative Nervous scores. Up to an additional 8% of the variability in post-operative Nervous scores were accounted for by MMPI-3 scales Emotional/Internalizing Dysfunction, Demoralization, Neurological Complaints, Suicidal/Death Ideation, Anxiety Related Experiences, Disconstraint, and Negative Emotionality/Neuroticism. Pre-surgical Anger scores accounted for 6% of the variability in post-surgical anger scores. MMPI-3 scales Behavioral/Externalizing Dysfunction, Antisocial Behaviors, Neurological Complaints, Juvenile Conduct Problems, and Disconstraint accounted for up to 7% of additional variability in postoperative Anger scores. 5% of the variability in post-operative Irritable scores were accounted for by pre-surgical Irritable scores. Emotional/Internalizing Dysfunction, Demoralization, Somatic Complaints, Neurological Complaints, Anxiety Related Experiences, Family Problems, and Negative Emotionality/Neuroticism scores accounted for up to 8% of additional variability in postoperative Irritable scores. Presurgical Fearful scores accounted for 1% of the variance in post-surgical Fearful scores. MMPI-3 scales Worry and Negative Emotionality/Neuroticism accounted for up to 8% additional variance in post-surgical Fearful scores. Pre-surgical Worry scores accounted for 3% of the

variability in post-surgical Worry scores. Emotional/Internalizing Dysfunction, Demoralization, Worry, and Negative Emotionality/Neuroticism accounted for up to 7% of additional variance in postoperative Worry score.

Discussion

Overall, pre-surgical MMPI-3 scores predicted outcomes with a similar pattern and magnitude to those found with the MMPI-2-RF (Block et al., 2017; Marek et al., 2019, 2021). As indicated in Table 2, many patients reported

Table 5 Correlations between the Pre-Surgical External Criteria, MMPI-3 Scale Scores, and Post-Surgical External Criteria

Pre-Surgical External Criteria	Current Pain Level (12 month) (n = 214)	Current Pain Interference with Lifestyle (12 month) (n = 214)	Oswestry Disability Index (12 month) (n = 183)
Current Pain Level	0.12*	0.08	0.14*
Current Pain Interference with Lifestyle	0.09	0.14*	0.17*
Oswestry Disability Index	0.19**	**0.24****	**0.38****
Depressed	0.14*	0.19**	**0.20****
Nervous	−0.05	−0.03	0.06
Anger	−0.01	0.03	−0.02
Irritable	0.01	0.05	0.08
Fearful	−0.01	0.05	0.02
Worried	−0.05	0.00	−0.02
Emotional/Internalizing Dysfunction	0.01	0.09	0.13*
Behavioral/Externalizing Dysfunction	0.09	0.16*	0.07
Demoralization	0.03	0.11	0.10
Somatic Complaints	**0.20****	**0.24****	**0.26****
Low Positive Emotions	−0.03	−0.03	0.06
Antisocial Behavior	0.11	0.15*	0.11
Dysfunctional Negative Emotions	0.02	0.09	0.14*
Hypomanic Activation	−0.01	0.05	−0.05
Malaise	0.15*	**0.20****	**0.28****
Neurological Complaints	**0.21****	**0.24****	**0.29****
Eating Concerns	0.02	0.09	0.17*
Cognitive Complaints	−0.01	0.02	0.06
Suicidal/Death Ideation	0.04	0.10	0.19**
Helplessness/Hopelessness	−0.02	0.06	0.04
Self Doubt	0.07	0.12*	0.09
Inefficacy	0.00	0.07	0.03
Stress	−0.03	0.08	0.06
Worry	−0.01	0.06	0.07
Compulsivity	0.06	0.01	0.02
Anxiety Related Experiences	0.06	0.16*	0.17*
Anger Proneness	−0.03	0.04	0.03
Behavior Restricting Fears	0.03	0.02	0.05
Family Problems	0.03	0.10	0.13*
Juvenile Conduct Problems	0.13*	0.14*	0.10
Substance Abuse	−0.01	0.02	0.01
Impulsivity	0.02	0.11*	−0.02
Activation	−0.05	−0.03	−0.07
Aggression	0.03	0.02	0.04
Cynicism	0.15*	0.17**	0.11
Aggressiveness	−0.01	−0.01	−0.11
Disconstraint	0.09	0.14*	0.05
Negative Emotionality/Neuroticism	0.01	0.09	0.10
Introversion/Low Positive Emotionality	−0.03	−0.03	0.01

Note. Correlations are bolded if they yielded a small to medium effect size and were statistically significant at $p < .05$; *indicates $p < .05$; ** indicates $p < .01$

Table 5 (Continued) Correlations between Pre-Surgical MMPI-3 Scale Scores and Post-Surgical External Criteria

Pre-Surgical External Criteria	Depressed (12 month) (n = 214)	Nervous (12 month) (n = 214)	Anger (12 month) (n = 214)	Irritable (12 month) (n = 214)	Fearful (12 month) (n = 214)	Worried (12 month) (n = 214)
Current Pain Level	0.05	0.00	0.03	0.04	−0.02	0.03
Current Pain Interference with Lifestyle	0.16**	0.16**	0.15*	0.08	0.07	0.11
Oswestry Disability Index	0.14*	0.15*	0.13*	0.13*	0.14*	0.13*
Depressed	**0.45****	**0.38****	**0.30****	**0.33****	**0.23****	**0.31****
Nervous	0.19**	**0.29****	0.13*	0.15*	**0.20****	0.19**
Anger	0.18**	0.16**	**0.25****	**0.27****	0.05	0.10
Irritable	**0.24****	**0.22****	**0.22****	**0.24****	0.07	0.12*
Fearful	0.00	0.07	0.01	0.10	0.12*	0.09
Worried	0.13*	0.21**	0.10	0.17**	0.14*	0.18**
Emotional/Internalizing Dysfunction	**0.37****	**0.26****	**0.24****	**0.28****	0.16*	**0.24****
Behavioral/Externalizing Dysfunction	**0.24****	**0.20****	**0.28****	**0.22****	0.10	0.16*
Demoralization	**0.41****	**0.28****	**0.24****	**0.31****	0.13*	**0.24****
Somatic Complaints	**0.20****	0.18**	**0.20****	**0.24****	0.09	0.15*
Low Positive Emotions	0.04	0.05	0.11	0.08	0.04	0.05
Antisocial Behavior	**0.27****	0.15*	**0.27****	**0.21****	0.08	0.15*
Dysfunctional Negative Emotions	**0.27****	**0.20****	**0.20****	**0.25****	0.15*	0.18**
Hypomanic Activation	0.15*	0.16**	0.19**	**0.21****	0.09	0.14*
Malaise	**0.25****	**0.21****	0.17**	**0.21****	0.10	0.19**
Neurological Complaints	0.13*	0.19**	**0.25****	**0.22****	0.07	0.13*
Eating Concerns	**0.23****	0.18**	0.13*	0.13*	0.03	0.13*
Cognitive Complaints	**0.34****	**0.23****	0.15*	**0.20****	0.06	0.07
Suicidal/Death Ideation	**0.28****	**0.23****	0.18**	0.13*	0.02	0.13*
Helplessness/Hopelessness	0.16*	0.02	0.09	0.06	0.05	0.11
Self Doubt	**0.23****	0.14*	0.10	0.19**	0.10	0.17**
Inefficacy	**0.28****	**0.24****	0.16**	**0.22****	0.12*	0.16*
Stress	**0.23****	**0.25****	0.12*	**0.24****	0.16**	**0.21****
Worry	**0.37****	**0.31****	**0.21****	**0.27****	**0.21****	**0.32****
Compulsivity	0.08	0.04	−0.01	0.08	0.07	0.05
Anxiety Related Experiences	**0.33****	**0.36****	**0.20****	**0.29****	**0.21****	**0.27****
Anger Proneness	0.16*	0.08	0.15*	0.17**	0.02	0.07
Behavior Restricting Fears	0.01	−0.02	−0.04	−0.02	−0.02	0.00
Family Problems	**0.23****	0.16**	**0.24****	**0.23****	0.09	0.13*
Juvenile Conduct Problems	**0.20****	0.15*	**0.27****	0.18**	0.03	0.11*
Substance Abuse	**0.23****	0.18**	0.15*	0.04	0.04	0.07
Impulsivity	0.18**	0.17**	0.19**	0.17**	0.14*	0.17**
Activation	0.08	0.13*	0.10	0.19**	0.08	0.06
Aggression	0.18**	0.14*	0.19**	**0.20****	0.06	0.04
Cynicism	0.19**	0.08	0.14*	**0.20****	0.05	0.08
Aggressiveness	0.01	−0.10	0.04	0.04	−0.16**	−0.13*
Disconstraint	**0.24****	**0.20****	**0.29****	0.19**	0.10	0.16*
Negative Emotionality/Neuroticism	**0.33****	**0.32****	**0.21****	**0.27****	**0.21****	**0.29****
Introversion/Low Positive Emotionality	−0.04	−0.02	0.01	0.00	0.01	0.02

Note. Correlations are bolded if they yielded a small to medium effect size and were statistically significant at $p < .05$; *indicates $p < .05$; ** indicates $p < .01$

improvements across domains, but the standard deviations tended to be larger one-year following surgery than they were prior to surgery. Consistent with our hypothesis, MMPI-3 scales explained 2–9% of the variability in outcome measures after controlling for their associated pre-surgical ratings. In some instances, the MMPI-3 scale scores accounted for more variability in the outcome than its corresponding pre-surgical predictor.

As just indicated, many patients reported improvements across domains. However, standard deviations tended to be larger one-year following surgery than they were prior to surgery. This indicated that the follow-up sample had more

Table 6 Hierarchical Regressions of Pre-Surgical MMPI-3 Substantive Scale Scores Predicting One-Year Outcomes after Controlling for Corresponding Pre-Surgical Markers

Postoperative Measure	MMPI-3 Scale Set	R^2	ΔR^2	Incremental MMPI-3 Scale Predictors
Current Pain Level (n = 214)	H-O	0.01	-	-
	RC	0.05	0.04	RC1
	Somatic/Cognitive	0.06	0.04	NUC
	Internalizing	0.01	-	-
	Externalizing	0.01	-	-
	PSY-5	0.01	-	-
Current Pain-Related Interference with Lifestyle (n = 214)	H-O	0.01	-	-
	RC	0.06	0.05	RC1
	Somatic/Cognitive	0.07	0.05	NUC
	Internalizing	0.01	-	-
	Externalizing	0.01	-	-
	PSY-5	0.01	-	-
Oswestry Disability Index (n = 183)	H-O	0.15	-	-
	RC	0.17	0.03	RC1
	Somatic/Cognitive	0.20	0.06	MLS, NUC
	Internalizing		-	-
	Externalizing		-	-
	PSY-5		-	-
Depressed (n = 214)	H-O	0.22	0.02	EID
	RC	0.26	0.06	RCd, RC2
	Somatic/Cognitive	0.20	-	-
	Internalizing	0.27	0.07	SUI, WRY
	Externalizing	0.22	0.02	JCP
	PSY-5	0.22	0.02	DISC
Nervous (n = 214)	H-O	0.11	0.02	EID
	RC	0.12	0.03	RCd
	Somatic/Cognitive	0.11	0.03	NUC
	Internalizing	0.20	0.09	SUI, ARX
	Externalizing	0.08	-	-
	PSY-5	0.13	0.05	DISC, NEGE
Anger (n = 214)	H-O	0.12	0.06	BXD
	RC	0.12	0.05	RC4
	Somatic/Cognitive	0.11	0.05	NUC
	Internalizing	0.11	0.02	WRY
	Externalizing	0.13	0.07	JCP
	PSY-5	0.12	0.06	DISC
Irritable (n = 214)	H-O	0.10	0.04	EID
	RC	0.14	0.08	RCd, RC1
	Somatic/Cognitive	0.11	0.04	NUC
	Internalizing	0.11	0.05	ARX
	Externalizing	0.11	0.05	FML
	PSY-5	0.09	0.04	NEGE
Fearful (n = 214)	H-O	0.01	-	-
	RC	0.01	-	-
	Somatic/Cognitive	0.01	-	-
	Internalizing	0.05	0.04	WRY
	Externalizing	0.01	-	-
	PSY-5	0.09	0.08	NEGE
Worry (n = 214)	H-O	0.07	0.03	EID
	RC	0.07	0.04	RCd
	Somatic/Cognitive	0.03	-	-
	Internalizing	0.10	0.07	WRY

Table 8 (continued)

Postoperative Measure	MMPI-3 Scale Set	R^2	ΔR^2	Incremental MMPI-3 Scale Predictors
	Externalizing	0.03	-	-
	PSY-5	0.09	0.06	NEGE

Note: MMPI-3 (Minnesota Multiphasic Personality Inventory – 3); RC (Restructured Clinical); PSY-5 (Personality Psychopathology – 5); EID (Emotional/Internalizing Dysfunction); BXD (Behavioral/Externalizing Dysfunction); RCd (Demoralization); RC1 (Somatic Complaints); RC2 (Low Positive Emotions); MLS (Malaise); NUC (Neurological Complaints); SUI (Suicidal/Death Ideation); WRY (Worry); ARX (Anxiety-Related Experiences); FML (Family Problems); JCP (Juvenile Conduct Problems); IMP (Impulsivity); CYN (Cynicism); DISC (Discontraint); NEGE (Negative Emotionality/Neuroticism);

variability in their ratings than they did prior to surgery. This finding is not surprising considering the literature indicating that elective spine surgery results can be variable, with some patients even reporting a worsening of their pain and functioning (Copay et al., 2010; Murray et al., 2023; Soroceanu et al., 2012). As the field continues to identify risk factors for poor outcomes and methods to mitigate them, standard deviations at outcome time points should become smaller in size assuming risks factors are being captured and needed interventions are being implemented prior to and/or following surgery. Regarding pre-surgical MMPI-3 substantive scale scores, psychopathology was often found in this sample. It is important to note that these means, standard deviations, and percent elevated statistics are reflective of a sample of individuals who were approved for surgery and underwent the surgical procedure, but are not reflective of the full range of scores typically observed in a comparison group sample [reported in a paper by Marek et al. (2022)]. Additionally, more than 1/3 of the sample engaged in some level of under-reporting that suppresses scale scores across substantive scale scores.

The correlations reported across Tables 4 and 5 demonstrate the ability of pre-surgical MMPI-3 scale scores to predict pain, pain interference with lifestyle, functional disability, and various markers of negative affect. MMPI-3 scales such as Somatic Complaints, Malaise, and Neurological Complaints consistently correlated with pain, pain interference with lifestyle, functional disability at both time points at similar magnitudes. These MMPI-3 measures aim to capture constructs associated with somatoform psychopathology. Aragona et al. (2008) demonstrated that items on Somatic Complaints and Malaise on the MMPI-2-RF did an adequate job differentiating patients with Pain Disorder from patients who experienced pain from a verified somatic origin. The construct validity of MMPI-2-RF measures of somatoform psychopathology was demonstrated with additional criteria (Marek, Anderson et al., 2020; Mickens et al., 2021; Woodling et al., 2022) This likely extends to the MMPI-3 versions of these scales.

Correlations reported across Tables 4 and 5 also demonstrate the ability of pre-surgical MMPI-3 Emotional/Internalizing Dysfunction and Behavioral/Externalizing Dysfunction scales to predict emotional functioning in spine surgery patients. Scales such as Demoralization, Low Positive Emotions, Dysfunctional Negative Emotions, and Negative Emotionality/Neuroticism yielded modest to large associations with emotional criteria at both time points. This pattern has been similarly reported with the MMPI-2-RF scale scores (Block et al., 2017; Marek et al., 2015, 2019, 2021). Although many patients reported a decrease in negative affect over time, these MMPI-3 scales accounted for variability reported negative affect one year after surgery. Some of the pre-surgical MMPI-3 Behavioral/Externalizing Dysfunction scale scores were also associated with emotional criteria (largely with Anger). These included Family Problems – which has consistently predicted poorer outcomes on the MMPI-2-RF (Block et al., 2017; Marek et al., 2015, 2019, 2021). One trend that was typically not observed on the MMPI-2-RF were the correlations between Disconstraint and negative affect – notably Nervousness and Anger. Patients who score higher on Disconstraint tend to act out impulsively, engage in acting out behaviors, and tend to be sensation- and excitement-seeking. In other settings, negative urgency has been identified as a method to relieve distress and anxiety by acting impulsively to alleviate these symptoms. Negative Urgency has been studied in samples as it relates to binge eating Kelly et al. (2014) and is correlated with Disconstraint modestly in the MMPI-3 Technical Manual (Ben-Porath & Tellegen, 2020b) in a sample of college students.

Hierarchical regression analyses established the incremental value the MMPI-3 scale scores have in predicting post-surgical outcomes above and beyond associated pre-surgical ratings. Pre-surgical MMPI-3 accounted for 2-9% of additional variability – sometimes accounting for more variance in the outcome measures than did patients' pre-surgical scores on the same measures – notably when predicting pain one-year following the intervention. These findings were largely consistent with those reported by Marek et al. (2015), who found that MMPI-2-RF scale scores accounted for 2-11% of additional variability in post-surgical outcomes 3–6 months following spine surgery. Consistent

with MMPI-2-RF outcome studies, Emotional/Internalizing Dysfunction, Demoralization, and Negative Emotionality/Neuroticism were the most frequent predictors of poor emotional functioning one year post-surgery. Further, Somatic Complaints, Malaise, and Neurological Complaints also emerged as significant predictors of post-surgical pain, pain related interference with lifestyle, functional disability, and emotional functioning. Updated MMPI-3 scale scores, including Worry and Anxiety-Related Experiences also emerged as consistent predictors of poorer emotional functioning one year after surgery.

The current investigation has limitations. The study utilized self-reported outcomes and the pain and emotional measures were single item rather than validated measured such as the Pain and Impairment Relationship Questionnaire (Slater et al., 1991) or the Inventory for Depression and Anxiety – II (Watson et al., 2012). Time constraints did not allow for the use of more comprehensive outcome measures. Additionally, there was quite a bit of attrition between the presurgical timepoint and the one-year follow-up. No incentives were offered to participate, making adherence to follow-up difficult to obtain. Because those who tended to score higher on Somatic Complaints and Neurological Complaints tended not to report outcome data, the results reported in this paper are likely underestimates of the predictive magnitude of these scales. Last, the sample was evenly split between men and women and representative of the age range of persons who seek surgical interventions for low back pain, diversity of race and ethnicity was not present in the setting where the data were collected. Greater efforts to recruit and include persons of various races and ethnicities is needed to determine whether the results of this investigation are generalize across diversity groups.

As discussed earlier, pre-surgical psychological assessments are more routinely being conducted in the United States to help assess risk and predict outcomes from elective procedures (Marek & Block, 2023a). Psychological testing is recommended to be included in these evaluations (Marek & Block, 2023b) and the MMPI instruments have a history of predicting diminished outcomes in spine surgery settings (Block et al., 2001, 2017; den Boer, Oostendorp, Beems, Munneke, Oerlemans et al., 2006b; Herron et al., 1992; Marek et al., 2015; Marek et al., 2021; Schocket et al., 2008; Spengler et al., 1990; Trief et al., 2000). The most up-to-date version of the test, the MMPI-3, provides reliable and valid scores in spine surgery settings (Marek et al., 2022). The current investigation extends these findings by demonstrating the validity of MMPI-3 scores in predicting one-year surgical outcomes.

Author Contributions Ryan J. Marek: Conceptualization, Formal Analysis, Project Administration, Investigation, Methodology, Software, Writing - original draft – review & edit. Janet T. Le: Formal Analysis, Writing - original draft. Gabriel Hapenciuc: Formal Analysis, Writing - original draft. Michelle A. Philip: Writing - original draft. Josephine Chiu: Writing - original draft. Andrew Block: Conceptualization, Data Curation, Funding Acquisition, Project Administration, Investigation,, Writing - review & edit. Yossef Ben-Porath: Conceptualization, Data Curation, Funding Acquisition, Project Administration, Investigation, Methodology, Writing - review & edit.

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Data Availability Although these data are not preregistered, data and SPSS syntax can be made available for replication purposes providing appropriate institutional agreements are met.

Declarations

Conflicts of Interest Yossef Ben-Porath is a paid consultant to the MMPI-3 publisher, the University of Minnesota and Distributor, Pearson. As co-author of the MMPI-3, he receives royalties on sales of the test.

Ethical Approval The IRBs at Kent State University (IRB-11-276) and Sam Houston State University (IRB-2022-178) have approved this study.

Consent to Participate All participants in this study provided informed consent.

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