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Original Research

Reliability and validity of chronic pain scales in adults with adverse childhood experiences

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ABSTRACT

Background: Chronic non-cancer pain (CNCP) affects millions of people and is a leading cause of disability. The progression of chronic pain is closely tied to anxiety and depression but less is known about the relationship between chronic pain and adverse childhood experiences (ACE). Two commonly used pain assessments, the short form-McGill pain questionnaire-2 (McGill) and the brief pain inventory short form (BPI), have been validated in populations with CNCP patients but have not been validated in populations of CNCP patients with ACE. In addition, we wanted to assess the test-retest reliability and internal consistency of the Brief Adverse Childhood Events Survey (BRACES), an original instrument developed by the authors, with CNCP patients. **Methods:** This study enrolled 123 patients with CNCP from an academic multidisciplinary pain clinic at the Clinical Trials Unit of our Clinical and Translational Science Center. ACE was not inclusion criteria. All patients had one of five CNCP pain diagnoses. We administered the three instruments twice, separated by 2 weeks. The analysis compared psychometric properties of the instruments in patients who had ACE and those who did not. **Results:** There was significant correlation of the scores between the two participant visits ($r = 0.68$, 0.85) and internal consistency was high (Cronbach-$\alpha = 0.68$, 0.85). Around 70% of the study participants endorsed one or more categories of ACE, and 30% of study participants endorsed four to six ACE categories. Agreement between visits for reported ACE categories was high ($\kappa = 0.72$, 0.85). Demographic and pain characteristics were not different between patients reporting ACE and those who did not. **Conclusions:** The McGill, BPI, and BRACES instruments were reliable and internally consistent in both populations. They also appear to be useful in evaluating the relationship between the quality (McGill), severity and interference (BPI) of CNCP in individuals with a history of ACE. Future research studying the relationship between ACE and chronic pain syndromes in adults can confidently utilize these instruments to help understand the role that ACE may play in the course of chronic pain and potential treatments.

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INTRODUCTION

Chronic non-cancer pain (CNCP), defined as lasting longer than the anticipated healing time of 3 months, is among the most prevalent U.S. health conditions, affecting 35% of the population with annual costs exceeding $635 billion [1-3]. CNCP results from a complex interaction between biological, psychosocial, and social factors. The association between pain and psychosocial comorbidities, like depression and anxiety, has been well documented [1,4-7]. Data are lacking on how best to treat CNCP with behavioral comorbidities but data suggests that improved coping skills, reduced disability, and greater resilience can improve outcomes and pain experience [8-14].

Literature examining the relationship between adverse childhood experiences (ACE) and CNCP is sparse. ACE are specific traumatic events in childhood that can have negative, long-lasting health effects. Literature on childhood adversity suggests that ACE is experienced by a large proportion of the population. However, depending on what categories of ACE are assessed; and the populations under study, the prevalences can vary widely [15-19]. Large meta-analyses demonstrate that individuals reporting abuse or neglect in childhood experience more pain syndromes, and individuals treated for chronic pain are more likely to have a history of ACE [20]. Adult females with histories of childhood sexual abuse report more multi-site chronic pain and fibromyalgia [21]. Adults with migraine headaches have a prevalence of ACE between 20% and 25% [22], and those with ACE are more likely to be disabled, depressed, anxious, and have multiple pain conditions [23-27]. Furthermore, some patients perceive the impact of ACE to be causal for their CNCP [18,28]. Further research is needed to understand the relationship between CNCP and ACE, but valid and reliable tools are needed.

The two most commonly used pain measurement tools used in clinical practice are the brief pain inventory (BPI) [29] and the McGill [29-32]. They have been shown to be reliable and valid in general CNCP patient populations [33-36]. However, to our knowledge, none of these instruments has been tested with CNCP patients who have experienced ACE.

The purposes of the current study were to assess test-retest reliability and internal consistency of these two clinical pain measures among CNCP patients, with and without histories of ACE, in the University of New Mexico Pain Center (UNMPC) and to assess the test-retest reliability of the Brief Adverse Childhood Events Survey (BRACES) instrument in this population.

METHODS

Study Design

This study used an analytic observational study design for assessing the test performance of the clinical measures [37].

Subjects

Patients from the UNMPC were identified using a patient database and a random sample of these patients was generated. Inclusion criteria included patients seen in the UNMPC between 12/20/2010 and 5/13/2013, 18 years of age and over, and having at least one of five pain diagnoses (tension headache ICD-9 307.81, migraine headache ICD-9 346.0, headache ICD-9 784.0, fibromyalgia ICD-9 729.1, or myofascial pain ICD-9 728.85). These diagnoses were selected because they are common in patients seen in CNCP clinics and also frequently reported in patients who report a history of ACE [18,22]. Because most patients had more than one pain diagnosis at each visit, patients with additional diagnoses, e.g., back, neck and arthritis pain, and CNCP were included if they had at least one of the five inclusion diagnoses. Patients were excluded if their pain was the result of surgery. The study was approved by the University of New Mexico (UNM) Human Subjects Review Board.

Survey Procedures

A computerized survey was implemented using the Research Electronic Data Capture (REDCap) system [38]. Each participant completed the survey in a private space and the research coordinator stayed in the room long enough to ensure the participant was comfortable completing the survey. Participants returned 2 weeks later for the second administration of the survey.

Measures

Socio-demographic and pain-related questions

Our socio-demographic questions asked about gender, race and Hispanic ethnicity, age, level of education, employment status, income, and partnership status. In addition, pain-related questions elicited pain diagnosis, duration of pain symptoms, and years of treatment for pain.

Pain: McGill and BPI

The BPI assesses pain intensity, pain interference with daily activities and pain interference with affect using a 0-10 scale. The BPI has been shown to be reliable in CNCP patients with Cronbach-α = 0.85, 0.88 [35,39].

The McGill is composed of 22 questions each of which includes a word intended to describe the different qualities of pain and related symptoms [32]. For each question, a 10 point scale is offered to indicate the intensity of pain the individual experienced in the last week. Participants are asked to check "0" if the word does not describe the pain or related symptoms. The McGill has been shown to be reliable with Cronbach-α = 0.91 [33].

Adverse Childhood Events

The Brief Adverse Childhood Events Survey (BRACES) measures whether or not the respondent had been exposed as a child to any of six types of abuse/maltreatment (ACE): Physical abuse, sexual abuse, emotional abuse, emotional neglect, physical neglect, and witnessing parental violence. The literature suggests these six types of ACE have the highest prevalence and create the highest risks of poor outcomes. The full instrument measures the perceived severity, frequency, age of onset, and the perceived impact and valence of each type of ACE, when the participant was a child and now, as an adult. For this study, a participant was considered to have experienced ACE if he or she answered "yes" to any one of the six categories at either of the two test administrations. In keeping with the seminal research on ACE, the sum of "yes" responses over these six categories of exposure was used as the total ACE score (range of 0-6) [40].

Analysis

Statistical analysis

All analyzes were performed in SAS 9.3 (SAS Institute, Cary, N.C., 2011) and Stata/SE 13.1 (StataCorp, College Station, TX, 2013). To determine whether the pain scales were internally consistent a two-sided F-test with a significance level of 0.05 was used to calculate sample size [41]. To achieve 95% power to detect the difference between the Cronbach alpha ($\alpha = 0.70$) and the most conservative published value of alpha for the reliability of the different pain scales ($\alpha = 0.85$), a sample size of $n = 61$ was required [42]. Based on previous studies conducted by the authors and others [40,43], it was assumed that 40-70% of the total sample would have at least one type of ACE [28] and there would be an attrition rate of 30% between the first and second administrations of the tests. Therefore, the goal was to recruit 120 CNCP participants to achieve a final sample that included sufficient representation of subjects with ACE.

Two different reliability assessment approaches were used: test-retest and internal consistency. Participant characteristics were stratified by ACE status and compared using two-sample *t*-tests for continuous variables and Chi-square or Fisher exact tests for categorical variables. Summary statistics were calculated by ACE status for the overall McGill Pain Assessment and the two subscales of the BPI (Interference and Severity) at both visits. The test-retest reliability was assessed for the BPI subscales, the McGill, and the ACE total score at the two visits using the paired *t*-test (BPI and McGill), the Wilcoxon signed-rank test (ACE total score), and Spearman correlation (BPI, McGill, and ACE total score). The Wilcoxon signed-rank test was used to compare the ACE total scores due to the possibility that the scores could follow a zero-inflated Poisson distribution. The Spearman rank correlation coefficient was chosen for all scales for robustness to sample size differences in the ACE ($n = 84$) and no ACE ($n = 36$) groups.

In addition, to assess the congruence of responses between visits, the percentage of participants who indicated experiencing each of the six types of ACE were compared using kappa statistics and 95% confidence intervals where $\kappa \geq 0.70$ was considered agreement. McNemar tests for paired frequencies were also performed for supporting evidence, and a $P > 0.05$ indicated consistent responses.

To graphically assess agreement between the visits, Bland-Altman plots were used [44,45], which plots the mean difference against the mean of the paired responses. If the majority of the data points fall within the 95% limits, the measurements are considered to agree, providing evidence of test-retest reliability. To assess internal consistency, Cronbach α coefficients were calculated for the BPI and McGill pain scales based on Visit 1 responses and an 1 responses and an agree, provide.

RESULTS

Socio-demographic and pain-related questions

The patient database generated 410 eligible subjects. Overall, 123 of 204 participants contacted (60%) were enrolled in the study. Three participants were excluded from the analysis for incomplete data, resulting in 120 participants. The mean age of participants was 50.9 years, and 65% were female, 72% Hispanics [Table 1]. The majority had some college education or higher (73%) while 58% had a yearly income <$30,000. Half of the participants were married or partnered. Almost half (47%) were physically disabled and unable to work. Interestingly, 53% classified their pain diagnosis as CNCP. The mean length of pain symptoms was 8.0 years with an average of 4.5 years of pain treatment. There were no significant differences in demographic or pain characteristics between participants reporting ACE and those who did not.

Pain Scales, ACE Measurement, Test-rest Reliability, and Internal Consistency

There were no differences between visits in the overall scores or by ACE category [Table 2]. Visit 1 and 2 scores correlated significantly with coefficients for the McGill being higher (range $r = 0.80, 0.85$) as compared to the BPI (range $r = 0.68, 0.78$). Figures 1a - 1c also show significant agreement between test and retest scores for the McGill and BPI severity and interference scales with only eight or fewer outliers. The internal consistency measures were high (Cronbach-$\alpha \geq 0.88$) for all three pain measures and corresponding ACE subgroups.

Overall, 84 (70%) of participants reported at least one type of ACE between the two survey visits [Table 3]. Visit 1 participants reported a total of 225 ACE events; visit 2, 222 events, for an

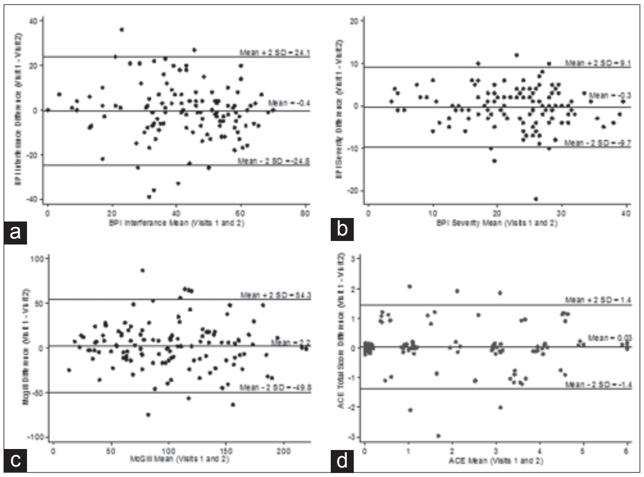

Figure 1: Bland-Altman plots for the brief pain inventory (BPI) interference, BPI severity, McGill total, and the adverse childhood experiences (ACE) questionnaires. A small jitter has been added to the ACE values to distinguish values. (a) BPI interference, (b) BPI severity, (c) McGill, (d) ACE

Table 1: Demographics and pain status by presence of ACE

Variable	Total sample (*n*=120)	Individuals with ACE (*n*=84)	Individuals without ACE (*n*=36)	*P* value
Gender: *n* (%)				
Female	78 (65)	54 (64)	24 (67)	0.80*
Male	42 (35)	30 (36)	12 (33)	
Race: *n* (%)				
American Indian/Alaska Native	4 (3)	1 (1)	3 (8)	0.12**
Black/African American	3 (2)	3 (4)	-	
Native Hawaiian/Pacific Islander	1 (1)	1 (1)	-	
White	86 (72)	63 (75)	23 (64)	
Some other race	20 (17)	11 (13)	9 (25)	
Two or more races	6 (5)	5 (6)	1 (3)	
Ethnicity: Hispanic: *n* (%)	42 (35)	29 (35)	13 (36)	0.87*
Age (years): Mean (SD)	50.9 (11.3)	51.0 (10.9)	50.7 (12.2)	0.89***
Education: *n* (%)				
<high school	5 (4)	3 (4)	2 (5)	0.84**
High school or equivalent	27 (23)	17 (20)	10 (28)	
Some college or associates degree	49 (41)	36 (43)	13 (36)	
Bachelor's	19 (16)	13 (15)	6 (17)	
Master's	11 (9)	9 (11)	2 (6)	
Professional school/doctorate	9 (7)	6 (7)	3 (8)	
Employment: *n* (%)				
Employed for wages	20 (17)	13 (16)	7 (19)	0.13**
Student	8 (7)	6 (7)	2 (6)	
Self employed	6 (5)	3 (4)	3 (8)	
Homemaker	3 (2)	-	3 (8)	
Retired	10 (8)	6 (7)	4 (11)	
Out of work for <1 year	2 (2)	2 (2)	-	
Out of work for more than 1 year	3 (2)	2 (2)	1 (3)	
Unable to work but not disabled	4 (3)	4 (5)	-	
Mentally/emotionally disabled and unable to work	7 (6)	5 (6)	2 (6)	
Physically disabled and unable to work	56 (47)	43 (51)	13 (36)	
Don't need to work	1 (1)	-	1 (3)	
Income: *n* (%)				
<$10,000	27 (23)	21 (25)	6 (17)	0.10**
$10,000-$19,999	22 (18)	17 (20)	5 (14)	
$20,000-$29,999	21 (17)	13 (15)	8 (22)	
$30,000-$39,999	13 (11)	8 (10)	5 (14)	
$40,000-$49,999	6 (5)	5 (6)	1 (3)	
$50,000-$74,999	18 (15)	15 (18)	3 (8)	
$75,000-$99,999	4 (3)	3 (4)	1 (3)	
$100,000-$124,999	2 (2)	-	2 (5)	
$125,000-$149,999	3 (3)	1 (1)	2 (6)	
$150,000 or higher	4 (3)	1 (1)	3 (8)	
Partnership status: *n* (%)				
Married or partnered	60 (50)	41 (49)	19 (53)	0.49*
Separated or divorced	22 (18)	17 (20)	5 (14)	
Widowed	8 (7)	7 (8)	1 (3)	
Single	30 (25)	19 (23)	11 (30)	
$^{\#}$In household: Mean (SD)	2.4 (1.5)	2.4 (1.5)	2.4 (1.6)	0.80***
Self-reported pain complaint (visit 1): *n* (%)				
Fibromyalgia/musculoskeletal pain	96 (80)	66 (79)	30 (83)	0.04**
Headache	8 (7)	4 (5)	4 (11)	
Muscle spasm	7 (6)	7 (8)	0 (0)	
Mixed	6 (5)	6 (7)	0 (0)	
Unknown	3 (2)	1 (1)	2 (6)	
Years of pain symptoms: Mean (SD)	8.0 (1.5)	8.0 (1.5)	8.0 (1.3)	1.00***
Years treated for pain: Mean (SD)	4.5 (1.0)	4.5 (1.1)	4.6 (0.9)	0.56***

*Chi-square test, **Fisher's exact test, ***Independent two-sample *t*-test, ACE: Adverse childhood experiences, SD: Standard deviation

average of 1.9 ACE events/participant, which did not differ between the two visits [Figure 1d]. Responses for the different types of ACE showed consistency between the visits with the highest for unwanted sexual experience ($\kappa = 0.91$) and the lowest for physical harm ($\kappa = 0.72$) [Table 3].

DISCUSSION

This study confirms the internal consistency and reliability of the short form McGill Pain Questionnaire-2 (McGill), the BPI short form, and the BRACES in a diverse population of CNCP

Table 2: Test-retest and internal consistency results for the McGill total scale and the BPI questionnaires

Instrument name	Visit 1	Visit 2	Test-retest			Internal consistency
	Mean (SD) Total	Mean (SD) Total	Mean (SD) difference	Paired *t*-statistic (*P* value)	Spearman correlation (*P* value)	Cronbach alpha
McGill						
All subjects (*n*=120)	102.5 (48.5)	100.3 (49.8)	2.2 (26.5)	*t*=0.93 (*P*=0.36)	*r*=0.85 (*P*<0.0001)	0.94
Individuals with ACE (*n*=84)	107.3 (48.2)	107.3 (50.7)	0.0 (26.6)	*t*=0.01 (*P*=0.99)	*r*=0.85 (*P*<0.0001)	0.94
Individuals without ACE (*n*=36)	91.3 (48.1)	83.9 (43.8)	7.4 (26.0)	*t*=1.71 (*P*=0.10)	*r*=0.80 (*P*<0.0001)	0.94
BPI interference						
All subjects (*n*=120)	41.4 (16.5)	41.8 (17.6)	–0.4 (12.5)	*t*=–0.32 (*P*=0.75)	*r*=0.72 (*P*<0.0001)	0.90
Individuals with ACE (*n*=84)	42.8 (16.2)	43.7 (16.6)	–0.9 (11.5)	*t*=–0.73 (*P*=0.47)	*r*=0.73 (*P*<0.0001)	0.90
Individuals without ACE (*n*=36)	38.3 (17.1)	37.4 (19.3)	0.9 (14.6)	*t*=0.38 (*P*=0.71)	*r*=0.68 (*P*<0.0001)	0.89
BPI severity						
All subjects (*n*=120)	22.2 (7.9)	22.5 (8.3)	–0.3 (4.8)	*t*=–0.74 (*P*=0.46)	*r*=0.78 (*P*<0.0001)	0.91
Individuals with ACE (*n*=84)	23.0 (8.0)	23.5 (8.1)	–0.5 (4.9)	*t*=–0.92 (*P*=0.36)	*r*=0.76 (*P*<0.0001)	0.92
Individuals without ACE (*n*=36)	20.3 (7.2)	20.2 (8.5)	0.1 (4.7)	*t*=0.07 (*P*=0.94)	*r*=0.76 (*P*<0.0001)	0.88

ACE: Adverse childhood experiences, SD: Standard deviation, BPI: Brief pain inventory

Table 3: Test-retest reliability results for the ACE questionnaire

Test-retest	*n* (%) (*n*=120)		Kappa (95% CI)	*P* value*
	Visit 1	Visit 2		
Types of ACE				
Parental violence	47 (39.2)	50 (41.7)	0.81 (0.70-0.92)	0.37
Physical harm	48 (40.0)	48 (40.0)	0.72 (0.60-0.85)	1.00
Unwanted sexual experience	43 (35.8)	40 (33.3)	0.91 (0.83-0.99)	0.18
Emotional/psychological mistreatment	48 (40.0)	48 (40.0)	0.76 (0.64-0.88)	1.00
Emotional neglect	29 (24.2)	28 (23.3)	0.75 (0.61-0.89)	0.76
Physical neglect	10 (8.3)	8 (6.7)	0.76 (0.53-0.99)	0.32
Any ACE (overall *n*=84, 70%)	80 (66.7)	76 (63.3)	0.78 (0.66-0.90)	0.25
	Mean (SD)	Mean (SD)	Mean difference (SD)	*P* value**
Total ACE score	1.9 (1.8)	1.9 (1.9)	0.03 (0.7)	0.63

*McNemar's test for paired frequencies, **Wilcoxon signed-rank test for the paired mean difference between visits 1 and 2, ACE: Adverse childhood experiences, SD: Standard deviation, CI: Confidence interval

patients, including a substantial proportion that had histories of ACE, who were referred for treatment for CNCP in a university-based chronic pain clinic. Responses to all three assessment tools were consistent across two visits, indicating that these tools can be used in subsequent research to better understand the relationship between ACE and CNCP.

CNCP is a subjective condition without objective biologic measurements. It affects 100 million Americans and 1.5 billion people worldwide [6,46]. The relationship between ACE and CNCP has only moderate empirical support. The 2005 National Comorbidity Study found that adults who experience sexual and/or physical abuse in childhood reported more health problems than those without such histories [47]. It is notable that 70% of the pain patients in our study reported at least one type of ACE with a mean of 1.9 each. The proportion endorsing each category of ACE ranged from 8.3% for physical neglect to 40% each for parental violence, physical harm, and psychological mistreatment. About 50% reported experiencing more than one ACE and 30% reported between four and six types of ACE. These rates of ACE are higher than those reported in the original ACE studies of primary care patients [40,48]. The rates in those patient populations demonstrated that 38% of patients reported more than one ACE and 12.5% reported four or more types of ACE. The prevalence of most individual ACE categories were higher in prevalence in our study compared to those reported by the original ACE studies (parental violence 39.2% in our study vs. 12.7%; physical abuse 40% vs. 28.3%; sexual abuse 35.8% vs. 20.7%; psychological abuse 40% vs. 10.6% and emotional neglect 24.2% vs. 14.8%) with the exception of similar rates of physical neglect (8.3% vs. 9.9%). This finding adds additional support to prior research reporting that histories of ACE are more common in pain patients than in other patient populations [20].

If this high prevalence of ACE we found among our cohort of CNCP patients is confirmed in other studies, ACE may be the most common behavioral comorbidity in this patient population with even higher rates than depression.

There were limitations to this study. It was conducted among patients of a multidisciplinary chronic pain referral clinic, which may have overestimated the prevalence of ACE in CNCP patients, compared to the general CNCP population. The majority of participants were well educated, and thus the consistency of these tools in patients with lower levels of education can only be inferred. Each individual reported having more than one pain diagnosis, and thus it became difficult to use strict diagnostic inclusion criteria to limit the types of pain patients enrolled. This may have been an advantage for this type of prevalence and correlational study because it provided a more robust representation of general CNCP patients. Unlike other studies where the definition of ACE includes common experiences such as divorce, parents with substance abuse, or a stressful home environment, the respondents in this study reported about more consequential types of ACE (physical, sexual, emotional abuse, emotional and physical neglect and witnessing parental violence). Population studies are needed to clarify the prevalence of ACE in CNCP patients. However, to study the relationship between CNCP and ACE in more depth, investigators must know their measurement instruments are reliable and valid.

In addition, in the process of this study, we informally asked a few participants about their impressions of these instruments. These conversations provided insights about the way some CNCP patients answer questions in these instruments. In clinical settings, there is an opportunity to ask questions and elicit additional information to clarify any confusion or uncertainty about the survey items, which is not always possible in a research setting. Since most patients experience more than one type of pain, the answers may not represent how they feel in general but rather related to the most prominent pain at the time of the assessment. A few patients raised concerns about the visual analog scale. One participant shared her story: *'They ask you to "Rate your pain" – give it a number. (I think) ten is like giving birth, but the (male) doctor said that "Giving birth (was) an 8, a head injury is a 10. Regular pain is from 1 to 6 or 7." How would he know?.'* Another raised an issue about a question on the BPI which asks about the percent reduction in pain. He suggested that a 0-10 scale to reflect change in pain levels as a result of treatment would be more consistent with the rest of the instrument. We typically ask participants about how they felt about answering the ACE questions. We learned that some who suffer from pain believe that providers think that their pain is "in their heads." For this reason, participants commented that an instrument assessing ACE or its emotional consequences might be more acceptable if it included an explanation about why we are interested in asking these types of questions. These concerns should be further explored in subsequent research.

The ultimate goal of this research is to provide valid and reliable instruments to help examine the relationship between ACE and chronic pain syndromes with a focus on pain intensity, pain interference with function, and the role that ACE plays in the course of chronic pain evaluation and treatment. The hope is that increased understanding of the interplay between childhood adversity and adult pain syndromes may lead to more effective and targeted treatment interventions in heterogeneous patient populations. This study has shown that the BPI, McGill, and BRACES are valid and reliable instruments in CNCP patients with ACE. Subsequent research can utilize these instruments to study the effectiveness of interventions used to treat CNCP patients with a history of ACE.

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