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Survive or Thrive? Longitudinal Relation Between Chronic Pain and Well-Being

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Abstract

Background The minimal literature on the relation between chronic pain and both eudaimonic (EWB) and hedonic well-being (HWB) examines the relation cross-sectionally, and most studies have examined chronic pain's effect only on psychopathology.

Methods Using a sample of 473 midlife and older adults with chronic pain, this study examined both the cross-sectional and longitudinal relations between chronic pain and EWB and HWB in addition to psychological distress.

Results Multiple-group longitudinal structural equation modeling revealed that chronic pain was related significantly and negatively to EWB and HWB, and significantly and positively to distress among both men and women. When examined longitudinally, chronic pain at time 1 was associated significantly only with decreased EWB at time 2, suggesting chronic pain's risk to psychological functioning, especially because of its long-term effects on future EWB.

Conclusions Our study provides a comprehensive picture of the way chronic pain is associated both with EWB and HWB, in addition to psychological distress. Further, chronic pain may have a lasting influence on EWB, while it may have little predictive value for future HWB and psychological distress. Our study supports well-being's relevance to chronic pain research and has the potential to guide prevention strategies and treatment for chronic pain using a positive psychological framework.

Keywords Chronic pain · Longitudinal · Hedonic well-being · Eudaimonic well-being

Often defined as intermittent or continuous pain that persists longer than 3 to 6 months or beyond the regular healing time for a given injury [1], chronic pain is a significant public health concern that affects 10% to over 50% of US adults, or approximately 100 million people [2, 3]. The annual cost associated with chronic pain is estimated to be between $560 and $635 billion [2]; however, the cost to individuals in diminished physical and mental health is immeasurable.

More researchers today are using a biopsychosocial model to examine the interplay between mental and physical health in studies of chronic pain. Indeed, more than any other pathology, chronic pain is linked inextricably to psychological and physical well-being [4], and there is a strong consensus in cross-sectional and longitudinal studies that chronic pain is related to current and future psychiatric illnesses [4–6]. For example, it has been documented well that chronic pain severity is associated with psychological distress, most commonly with depression [7, 8] and anxiety [9, 10]. Indeed, one longitudinal study revealed that chronic pain at one time is predictive of higher levels of psychological distress 12 months later [6].

Psychological well-being usually is conceptualized as a combination of two perspectives: the hedonic perspective (positive affective states, such as happiness) and eudaimonic perspective (optimal effectiveness and meaning in life) [11, 12]. The hedonic view has been described as HWB, a construct derived empirically, and a scientific term used to examine so-called happy lives [13]. HWB consists of both affective (the degree to which people have positive and negative affect) and cognitive (the degree to which one is satisfied with one's

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life) components. From this hedonic perspective, people experience "happiness" when they have higher positive affect, lower negative affect, and greater satisfaction with life [14]. On the other hand, EWB concerns personal meaning and growth in one's life, which differs from happiness [12]. This perspective is based on Maslow's idea of self-actualization and Roger's concept of people who function fully and their HWB. According to this perspective, people experience well-being when they have a life purpose, challenges, and growth. These two viewpoints of well-being have been found to be correlated moderately, but research indicates that both foci overlap and yet are distinct [12]. Therefore, well-being is understood best by applying both hedonic and eudaimonic models [15].

While several studies have examined the relation between chronic pain and psychological health, several major limitations exist. First, most studies of chronic pain and psychological distress have used cross-sectional data, including people who report having chronic pain at one time in their lives, which limits our understanding of the temporal relations among the variables. Less is known about people who have chronic pain that recur over time. Second, most studies have focused exclusively on psychological distress [6, 10, 16], and there is a paucity of research that has investigated positive psychological functioning among people with chronic pain. In addition, even when studies included well-being in their inquiry, hedonic well-being (HWB), as measured by life satisfaction, was examined most often [16, 17]; few studies examined eudaimonic well-being (EWB) or both EWB and HWB in the context of chronic pain [5, 19, 20]. Because ill-being and well-being are related conceptually, but distinct constructs [20], one is not the mere opposite of the other. Thus, having a pathology is not always inversely related to having greater levels of well-being [21–23]. Furthermore, the majority of studies in this line of inquiry have included patients selected highly from specialty pain clinics, which could have biased prevalence rates and associations [24]. Finally, although gender differences have been extensively examined with regard to severity and intensity of chronic pain [9, 25], little is known about gender differences regarding the extent to which chronic pain impacts well-being and psychological distress. In addition, there are no studies examining the gender differences in each of the eudaimonic well-being subscales [26, 27]. Given that gender is one of the most frequently considered contextual factors in chronic pain management, we believe it is important to examine gender differences in the association between pain interference and well-being.

Generally speaking, based on studies that have examined certain dimensions of well-being and chronic pain interference, chronic pain's effect was related largely to diminished EWB and HWB [5, 18]. Similarly, the presence of meaning in life was associated with optimal adjustment to chronic pain conditions [18]. However, most studies measured either HWB (e.g., life satisfaction) [16, 17] or a single component of EWB (e.g., meaning in life) [18], making it difficult to assess the relation between well-being and chronic pain holistically. Based on the conceptual model of allostatic load, which describes cumulative physiological wear and tear resulting from repeated efforts to adapt to stress over time [28], it is likely that people who experience pain interference will be more vulnerable to decreased well-being and increased psychological stress because they experience an amplified stress response that results in decreased ability, interest, and engagement in activities that they used to find enjoyable.

Regarding positive psychological functioning, limited empirical findings showed that women had significantly higher levels of positive relations with others than did men, a gender difference that was larger than those observed for each of the each of the eudaimonic well-being subscales [26, 27]. Based on these findings, it is possible that the impact of recurring chronic pain interference on one's eudaimonic well-being might be greater for women because they are likely to be more "relationship-oriented" than men. Consequently, their eudaimonic well-being may be more compromised than those of men when they encounter chronic pain.

To date, two studies have examined both HWB, EWB, and chronic pain interference [5, 18]. Generally speaking, the level of chronic pain interference was largely related to HWB and EWB [5, 18]. Similarly, presence of meaning in life was associated with an optimal adjustment to a chronic pain condition [18]. With the exception of these studies, most others measured either HWB (e.g., life satisfaction) [16, 17] or a component of EWB (e.g., meaning in life) [18], making it difficult to assess the holistic view on the relation between well-being and chronic pain interference.

This study used a nationally representative dataset to investigate the 10-year trajectory of the relation between chronic pain interference and both hedonic and eudaimonic perspectives of well-being, as well as psychological distress. Our analyses adjusted for the potential confounds of comorbid physical and psychological illness. We examined first the concurrent relation between chronic pain interference and well-being. Then, we examined whether chronic pain interference reported at time 1 would predict future well-being at time 2 (10 years later). The aim of the study regarding the relation between pain interference and HWB and SWB is rather exploratory than confirmatory given the lack of studies that examined both HWB and SWB with people with chronic pain. With both models, we examined gender differences to investigate whether and the way in which the association between chronic pain interference and well-being differs by gender.

Methods

Participants

Data were drawn from the Midlife Development in the USA (MIDUS) studies. Originally, 7108 individuals participated in MIDUS I [29]. A total of 4963 individuals participated in MIDUS-II [30], and 3294 individuals participated in MIDUS-III [31]. In this study, we used both datasets. Because of the nature of our study, 545 participants who experienced pain at both time points were included. However, because 72 participants did not complete at least half of all the questionnaires, the final sample resulted in 473 adults (61.1% women, 38.9% men). When qualitative differences between these two groups were examined, participants who did not complete at least half of the questionnaires were significantly older ($M = 61.43$, $SD = 11.57$) compared to those who completed most of the questionnaires ($M = 56.34$, $SD = 10.71$; $t_{543} = -3.71$, $p < .001$). No differences were found with respect to gender ($\chi^2_1 = 0.21$, $p = .650$) and race ($\chi^2_4 = 6.91$, $p = .14$). Furthermore, there were no differences in pain levels in both MIDUS-II ($t_{537} = -0.58$, $p = .56$) and MIDUS-III ($t_{505} = -0.78$, $p = .44$). Participants' ages in the final sample ranged from 34 to 84 years ($M = 56.34$, $SD = 10.71$) in MIDUS-II, and their ethnicities were reported as follows: 89.6% Caucasian, 4.9% multi-racial, 2.5% African American, 2.5% Others, and 0.4% Native Americans. The study received ethical approval from the Institutional Review Board at the University of Wisconsin-Madison.

Measures

Chronic Pain Interference To measure chronic pain, a screening item in MIDUS was used first to assess whether participants had pain that lasted a long period ("Do you have chronic pain, that is do you have pain that persists beyond the time of normal healing and has lasted from anywhere from a few months to many years?") [32]. The scores on the Brief Pain Inventory (BPI) interference scale were examined for participants who answered "yes" [32]. BPI examines daily pain interference and has good psychometric properties [33]. Some items in the full 7-item scale may not be appropriate for certain populations [32, 34–36], especially since the MIDUS study used a community sample while the full 7-item scale has typically been used in clinical populations [32, 34–36]. Consequently, the principal investigators for the MIDUS study used the shortened 5-item to assess pain interference, from which two items assessing for pain interference in "walking ability" and "normal work (includes both work outside the home and housework)" were excluded [32, 34–36]. This shortened scale has been shown to have excellent internal consistency (Cronbach's $\alpha = 0.95$) [32]. It assesses for pain interference across the following five domains: general activity; mood; relationships with others; sleep, and enjoyment of life during the past week [32, 37, 38]. Participants responded to these questions on a scale of 1 to 10, in which 1 indicates "did not interfere" and 10 "completely interfered" [32, 37, 38]. These items were averaged to obtain a score for chronic pain interference overall, with higher scores reflecting greater interference.

Hedonic Well-Being The following three indicators were assessed in the sample to measure HWB: negative affect, positive affect, and life satisfaction. Scales that measured both positive and negative affect were developed specifically for the MIDUS survey. Scale items were adopted from a variety of well-known and valid instruments, including the Affect Balance Scale [39], the University of Michigan's Composite International Diagnostic Interview [40], the Manifest Anxiety Scale [41], and the Center for Epidemiological Studies Depression Scale. [42]

Positive and Negative Affect Participants were asked to rate the frequency of positive (e.g., "During the past 30 days, how much of the time did you feel cheerful?") and negative (e.g., "During the past 30 days, how much of the time did you feel so sad nothing could cheer you up?") characteristics in their affect based on a list of 6 adjectives for each construct. Participants responded to each item on a scale that ranged from 1 (*all of the time)* to 5 (*none of the time*). All the items were recoded such that higher scores reflected higher levels of positive and negative affect, and scores on all of the items were averaged to obtain an overall score of positive and negative affect. Positive affect was measured with six items on which respondents rated how often during the past month they had felt "cheerful," "in good spirits," "extremely happy," "calm and peaceful," "satisfied," and "full of life" on a scale that ranged from 1 (*all of the time*) to 5 (*none of the time*; see [43]). Negative affect was assessed with six items on which respondents rated how often during the past month they had felt "so sad that nothing could cheer them up", "nervous," "restless or fidgety," "hopeless," "that everything was an effort," and "worthless" on a scale that ranged from 1 (*all of the time*) to 5 (*none of the time*; see [44]). Positive affect has been reported to be positively correlated with life satisfaction [45] and negatively correlated with somatic amplification and physical symptom severity [46]. Negative affect has been reported to be positively correlated with somatic amplification and physical symptom severity [46] and negatively associated with life satisfaction [45]. Based on the MIDUS study's current sample, the measures of positive ($\alpha = 0.90$) and negative affect ($\alpha = 0.85$) had good levels of internal consistency.

Life Satisfaction The MIDUS study included the measure of life satisfaction based on perceived satisfaction in specific life domains [47]). A single composite life satisfaction score was

created by averaging participants' scores of their satisfaction with life, work, children, and health. Thus, a single item of life satisfaction was used at both time 1 and time 2 (e.g., "On a scale of 0 to 10 where 0 means the worst and 10 means the best how would you rate your life these days?"). The validity and reliability of this approach has been well documented [48–50]. For example, life satisfaction exhibits clear discriminant validity from related constructs such as positive affect, negative affect, and self-esteem [51]. It also predicts health and longevity [52]. Estimates for this single-item life satisfaction measure have been found to have reliability value of 0.70 across four national panel studies [49]. Participants responded to the question using an 11-point Likert scale that ranged from 0 (*the worst possible*) to 10 (*the best possible*) in which higher scores indicated greater life satisfaction. The item also demonstrates adequate parallel-form reliability [53, 54].

Eudaimonic Well-Being Participants' EWB was assessed using the 42-item version of Ryff's Scales of Psychological Well-being (RPWB) [22], a scale used to measure various components of positive psychological health [27]. It contains 6 subscales: autonomy (e.g., "I am not afraid to voice my opinions, even when they are in opposition to the opinions of most people"), environmental mastery (e.g., "In general, I feel I am in charge of the situation in which I live"), personal growth (e.g., "I am not interested in activities that will expand my horizons"), positive relationships with others (e.g., "Most people see me as a loving and affectionate"), purpose in life (e.g., "I live life one day at a time and don't really think about the future"), and self-acceptance (e.g., "In general, I feel confident and positive about myself") [27]. Each subscale includes seven items, which are rated on a 7-point scale that ranges from 1 (strongly agree) to 7 (strongly disagree) [27]. Certain items on each subscale were recoded, such that higher ratings reflected greater well-being. Again, items in each subscale were summed to obtain the subscale score overall. The RPWB in the current MIDUS sample displayed acceptable to good levels of internal consistency across all the subscales at time 1 (α = 0.70–0.84) and time 2 (α = 0.69–0.84).

Psychological Distress Psychological distress was assessed with three indicators: depression, generalized anxiety, and panic attacks. These constructs were measured using scales developed for the MIDUS survey based on the criteria and definitions in the American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R) [55] and the World Health Organization's (WHO) Composite International Diagnostic Interview—Short Form (CIDI-SF) [56]. These diagnoses have been found to have good test-retest reliability and clinical validity [57].

All 13 items on the depression scale were distributed between 2 subscales of depressed affect (e.g., "During two weeks in the past 12 months, when you felt sad, blue, or depressed, did you feel down on yourself, no good, or worthless?") and anhedonia (e.g., "During two weeks in the past 12 months, when you lost interest in most things, did you feel more tired out or low on energy than is usual?"). Participants responded to these items with either "yes" or "no." The number of yes responses was summed for each subscale first, and then the responses across both subscales were summed for the depression score overall. A higher score overall indicated more severe depression. The scale displays good psychometric properties, with a sensitivity of 0.73 and specificity of 0.82 in comparison to a semi-structured clinical diagnostic interview [58]. It also demonstrates high sensitivity of 89.6 and high specificity of 93.9 in comparison to the full CIDI classifications in the National Comorbidity Survey (NCS) [40, 59].

The generalized anxiety scale consists of 10 items that assess the frequency of anxiety symptoms during the past year (e.g., "How often, over the past 12 months, you were restless because of your worry"). Participants responded to these items on a 4-point scale that ranged from 1 (most days) to 4 (never). The generalized anxiety score overall was calculated by adding all of the "most days" responses to the items, in which a higher score reflects greater generalized anxiety. Comparison of the GAD classification to the full CIDI classifications in the National Comorbidity Survey (NCS) demonstrates a high sensitivity of 96.6 and specificity of 99.8 [40, 59].

A total of six items was used to assess symptoms of panic attacks (e.g., "When you have attacks, your heart pounds"). Participants responded to each of these items by indicating either yes or no. The panic attack score overall was calculated by adding the number of yes responses to the items, in which a higher score overall was indicative of greater panic attack severity. The classification for panic attacks exhibits excellent psychometric properties, with a sensitivity of 90.0 and specificity of 99.5 [40, 59].

Physical Illness

Physical illness covariates were selected from the MIDUS-II and MIDUS-III datasets based on their potential effects on chronic pain and well-being. The following conditions were examined in analyses and had the preface, "In the past 12 months, have you experienced or been treated for any of the following?": heart problems or heart attack; high blood pressure or hypertension; diabetes or high blood sugar; cancer; asthma; tuberculosis; other lung problems; sciatica, lumbago, or recurring backache; migraine headaches; persistent skin trouble; thyroid disease; hay fever; recurring stomach trouble, indigestion, or diarrhea; urinary or bladder problems; being constipated most or all of the time; gall bladder trouble; ulcer; hernia or rupture; piles or hemorrhoids; AIDS or HIV infection; lupus or other autoimmune disorders; multiple sclerosis, epilepsy, or other neurological disorders; stroke; persistent trouble with your gums or mouth; persistent trouble with your

teeth; swallowing problems; persistent foot trouble; trouble with varicose veins requiring medical treatment; or alcohol or drug problems. We coded a physical illness score for both time points based on the Medical History Severity Index developed by Benyamini and colleagues [60, 61].

Data Analysis

To examine the relations among chronic pain interference, well-being, and psychological distress between women and men across the two time points, multiple-group longitudinal structural equation modeling was performed. For HWB, scores of negative and positive affect and life satisfaction were used as indicators, and for EWB, the six subscales from RPWB were used. For psychological distress, depression, generalized anxiety, and panic attacks were used as indicators, and the individual scale items were used as indicators of pain. Measurement invariance was assessed by testing a sequence of factorial invariance across both time and gender. In examining longitudinal models, researchers have argued that an appropriate null model should assume that each indicator's intercepts and variances are equal across all measurement occasions [62, 63]. Therefore, we calculated the longitudinal null model in which each indicator has one variance, all covariances are fixed to zero, and variances and means are constrained to be equal over time. Assessment of structural models was conducted after the measurement invariance was established. Because the chi-squared statistic is sensitive to sample size, the following criteria also were used to assess the model's fit: values greater than 0.90 for the comparative fit index (CFI) and standardized root mean squared residual (SRMR) values < 0.10 are considered acceptable [64]. In addition, root mean square error of approximation (RMSEA) values < 0.05 indicate good fit, and values between 0.05–0.10 indicate adequate fit [65]. All analyses were conducted with Mplus v. 8.0 [66]. A total of 1.7% of all responses to the survey items totaled in the current measures were missing, and these missing data were addressed using Full Information Maximum Likelihood (FIML).

Results

Means, standard deviations, and correlations were calculated for pain interference, HWB, EWB, and psychological distress (see Table 1). Pain at MIDUS-II was positively correlated with negative affect, and psychological distress (i.e., depression, anxiety and panic attacks) assessed at both MIDUS-II and MIDUS-III ($r = .18$ to $.52$, $p < .001$) and negatively correlated with life satisfaction, positive affect, and all subscales of EWB at both timepoints ($r = -.13$ to $-.46$, $p < .01$). Furthermore, all of the measures assessed at MIDUS-II were significantly associated with the corresponding measures at MIDUS-III ($r = .27$ to 70, $p < .001$), indicating a certain level of stability across the 10-year timespan.

Multiple-Group Longitudinal Structural Equation Modeling

Measurement Invariance Multiple-group longitudinal measurement invariance was examined to assess whether latent factors were invariant between genders and across the two time points. The first model was a configural model in which both genders were included in a joint analysis, but there were no equality constraints between them and over time. Then, a series of models with additional constraints was examined by assessing the model fit and the degree of decrement in the fit compared to the previous model. In evaluating the measurement invariance, the decrement in goodness of fit was assessed by comparing it to the previous model. Specifically, a criterion of change in the Comparative Fit Index (ΔCFI) < .01 [67] indicated there was no significant decrease in the model fit. The partial strong measurement invariance was established between genders and over time after allowing the intercept of item 5 ("On a scale of 0 to 10, circle the number below that best describes how much, during the past week, your pain interfered with your sleep.") of the Pain Scale in MIDUS-II to vary between genders. This final model resulted in $\chi^2_{1041} = 1882.46$, $p < .001$, SRMR = 0.07, CFI = 0.93, and RMSEA = 0.06 (90% CI [.05, .06]). We accepted this partial strong invariance model, and the measurement portion of all subsequent models used the same restrictions as this model. Detailed description of the measurement invariance testing is discussed in the supplemental document.

Structural Model Given that the partial strong measurement invariance was established between genders and over time, regression paths were examined. Specifically, the relations among pain interference, well-being, and distress were assessed between the genders.

First Model The first model examined the way pain interference is associated with HWB, EWB, and distress, controlling for age and physical illness. The unconstrained model, in which all paths were allowed to vary between genders, produced the following results: $\chi^2_{303} = 702.45$, $p < .001$; SRMR = 0.06; CFI = 0.92; RMSEA = 0.08, 90% CI [0.07, 0.08]. To compare the gender difference, the unconstrained and constrained models were compared (with all regression paths and covariances set equal across genders: $\chi^2_{309} = 717.42$, $p < .001$; SRMR = 0.08, CFI = 0.92; RMSEA = 0.08, 90% CI [0.07, 0.08]). The chi-squared difference test produced a significant difference between these models ($\Delta\chi^2_6 = 14.98$, $p = .02$), indicating that there are significant differences in the regression paths and covariances between genders.

Table 1 Means, standard deviations, and zero-order correlations among chronic pain interference, well-being, and psychological distress in MIDUS-II and MIDUS-III

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Pain (M2)	3.39	2.53	1.00												
2. LS (M2)	7.55	1.55	− *0.34*	1.00											
3. NA (M2)	1.66	0.63	*0.52*	− *0.50*	1.00										
4. PA (M2)	3.24	0.74	− *0.46*	*0.58*	− *0.66*	1.00									
5. AU (M2)	37.22	7.01	− 0.13**	*0.22*	− *0.29*	*0.26*	1.00								
6. EM (M2)	36.94	7.88	− *0.32*	*0.58*	− *0.64*	*0.66*	*0.49*	1.00							
7. PG (M2)	38.10	7.13	− *0.27*	*0.45*	− *0.42*	*0.42*	*0.42*	*0.60*	1.00						
8. PR (M2)	40.44	7.07	− *0.25*	*0.44*	− *0.46*	*0.48*	*0.34*	*0.63*	*0.58*	1.00					
9. PL (M2)	38.03	7.08	− *0.29*	*0.50*	− *0.50*	*0.51*	*0.38*	*0.66*	*0.72*	*0.61*	1.00				
10. SA (M2)	36.84	8.76	− *0.34*	*0.64*	− *0.62*	*0.66*	*0.48*	*0.78*	*0.64*	*0.63*	*0.73*	1.00			
11. DEP (M2)	1.03	2.18	*0.35*	− *0.32*	*0.50*	− *0.37*	− *0.22*	− *0.37*	− *0.25*	− *0.25*	− *0.28*	− *0.39*	1.00		
12. GAD (M2)	0.22	1.17	*0.25*	− *0.26*	*0.40*	− *0.27*	− *0.17*	− *0.30*	− *0.23*	− *0.22*	− *0.22*	− *0.29*	*0.34*	1.00	
13. PAN (M2)	0.50	1.30	*0.22*	− *0.17*	*0.22*	− 0.15**	− 0.07	− *0.20*	− 0.08	− 0.10*	− 0.08	− 0.16**	*0.24*	0.05	1.00
14. Pain (M3)	3.59	2.66	*0.55*	− *0.26*	*0.39*	− *0.30*	− 0.06	− *0.26*	− *0.21*	− *0.18*	− *0.23*	− *0.28*	*0.29*	*0.22*	*0.18*
15. LS (M3)	7.47	1.82	− *0.26*	*0.52*	− *0.35*	*0.45*	0.13**	*0.42*	*0.31*	*0.33*	*0.37*	*0.50*	− *0.18*	− *0.26*	− 0.15**
16. NA (M3)	1.66	0.67	*0.37*	− *0.34*	*0.60*	− *0.44*	− *0.20*	− *0.46*	− *0.33*	− *0.34*	− *0.36*	− *0.44*	*0.34*	*0.32*	0.16
17. PA (M3)	3.24	0.73	− *0.34*	*0.44*	− *0.45*	*0.60*	*0.19*	*0.48*	*0.32*	*0.37*	*0.43*	*0.52*	− *0.28*	− *0.22*	− 0.05
18. AU (M3)	36.92	6.79	− 0.15**	*0.16*	− *0.21*	*0.17*	*0.65*	*0.35*	*0.35*	*0.22*	*0.30*	*0.37*	− 0.15**	− 0.11*	− 0.07
19. EM (M3)	36.71	8.04	− *0.27*	*0.42*	− *0.43*	*0.41*	*0.38*	*0.61*	*0.42*	*0.42*	*0.50*	*0.58*	− *0.22*	− *0.23*	− 0.11*
20. PG (M3)	37.46	7.05	− *0.27*	*0.35*	− *0.34*	*0.30*	*0.29*	*0.42*	*0.65*	*0.37*	*0.53*	*0.47*	− *0.16*	− *0.19*	− 0.09
21. PR (M3)	40.00	7.01	− *0.24*	*0.40*	− *0.39*	*0.38*	*0.23*	*0.48*	*0.45*	*0.65*	*0.49*	*0.52*	− *0.19*	− *0.20*	− 0.10*
22. PL (M3)	36.96	6.97	− *0.28*	*0.36*	− *0.41*	*0.36*	*0.32*	*0.49*	*0.54*	*0.44*	*0.65*	*0.53*	− *0.25*	− *0.23*	− 0.09
23. SA (M3)	36.32	8.63	− *0.32*	*0.48*	− *0.51*	*0.45*	*0.39*	*0.59*	*0.48*	*0.46*	*0.54*	*0.70*	− *0.31*	− *0.27*	− 0.14**
24. DEP (M3)	1.12	2.26	*0.28*	− *0.22*	*0.36*	− *0.29*	− 0.13**	− *0.28*	− *0.18*	− *0.25*	− *0.24*	− *0.30*	*0.38*	*0.27*	0.07
25. GAD (M3)	0.24	1.21	*.18*	− 0.15**	*0.35*	− *0.20*	− 0.15**	− *0.25*	− *0.18*	− *0.17*	− *0.18*	− *0.24*	*0.29*	*0.58*	0.02
26. PAN (M3)	0.40	1.10	*0.21*	− 0.11*	*0.27*	− *0.15*	− 0.03	− *0.22*	− 0.14**	− 0.15**	− *0.18*	− *0.19*	*0.20*	0.07	*0.27*

Variable	14	15	16	17	18	19	20	21	22	23	24	25	26
1. Pain (M2)													
2. LS (M2)													
3. NA (M2)													
4. PA (M2)													
5. AU (M2)													
6. EM (M2)													
7. PG (M2)													
8. PR (M2)													
9. PL (M2)													
10. SA (M2)													
11. DEP (M2)													
12. GAD (M2)													
13. PAN (M2)													
14. Pain (M3)	1.00												
15. LS (M3)	− *0.29*	1.00											
16. NA (M3)	*0.49*	− *.48*	1.00										
17. PA (M3)	− *0.40*	*0.57*	− *0.61*	1.00									
18. AU (M3)	− 0.12**	0.15**	− *0.27*	*0.20*	1.00								

Table 1 (continued)

Variable	14	15	16	17	18	19	20	21	22	23	24	25	26
19. EM (M3)	*− 0.31*	*0.56*	*− 0.58*	*0.58*	*0.53*	1.00							
20. PG (M3)	*− 0.26*	*0.43*	*− 0.44*	*0.41*	*0.43*	*0.61*	1.00						
21. PR (M3)	*− 0.25*	*0.49*	*− 0.46*	*0.51*	*0.31*	*0.63*	*0.55*	1.00					
22. PL (M3)	*− 0.32*	*0.44*	*− 0.48*	*0.49*	*0.47*	*0.68*	*0.71*	*0.58*	1.00				
23. SA (M3)	*− 0.32*	*0.58*	*− 0.57*	*0.59*	*0.50*	*0.76*	*0.63*	*0.66*	*0.69*	1.00			
24. DEP (M3)	*0.27*	*− 0.26*	*0.43*	*− 0.40*	*− 0.12***	*− 0.32*	*− 0.17*	*− 0.27*	*− 0.31*	*− 0.35*	1.00		
25. GAD (M3)	*0.18*	*− 0.23*	*0.35*	*− 0.24*	*− 0.15***	*− 0.28*	*− 0.17*	*− 0.18*	*− 0.22*	*− 0.30*	*0.38*	1.00	
26. PAN (M3)	*0.19*	*− 0.22*	*0.32*	*− 0.19*	*− 0.04*	*− 0.17*	*− 0.10**	*− 0.17*	*− 0.17*	*− 0.17*	*.26*	*.11**	1.00

M2 MIDUS-II, *M3* MIDUS-III, *LS* life satisfaction, *NA* negative affect, *PA* positive affect, *AU* autonomy, *EM* environmental mastery, *PG* personal growth, *PR* positive relations, *PL* purpose in life, *SA* self-acceptance, *DEP* depression, *GAD* generalized anxiety, *PAN* panic attacks

Italics indicate significance at the $p < .001$; **$p < .01$; *$p < .05$

To assess which regression paths or covariances should be estimated freely between genders, we conducted a chi-squared difference test. When the covariance between HWB and distress was constrained to be equal across genders, the model resulted in a significantly worse fit compared to the unconstrained model ($\Delta\chi^2_1 = 9.72$, $p = .002$). Similarly, the model fit worsened when the covariance between EWB and distress was constrained to be equal compared to the unconstrained model ($\Delta\chi^2_1 = 5.83$, $p = .016$). All regression paths and other covariances also were constrained to be equal across genders. Following these modifications, the final model produced an acceptable model fit: ($\chi^2_{307} = 706.35$, $p < .001$; SRMR = 0.07, CFI = 0.92; RMSEA = 0.07, 90% CI [0.07, 0.08]). Compared to the unconstrained model, the chi-squared difference test produced a non-significant difference between these models ($\Delta\chi^2_4 = 3.90$, $p = .420$). Negative associations were found between pain interference and both HWB ($\beta = -0.60$, $SE = 0.05$, $p < .001$; $\beta = -0.55$, $SE = 0.04$, $p < .001$ for men and women, respectively) and EWB ($\beta = -0.38$, $SE = 0.05$, $p < .001$; $\beta = -0.35$, $SE = .05$, $p < .001$ for men and women, respectively). See Figs. 1 and 2 for correlations.

Second Mode For the second model, a longitudinal panel model was constructed to examine whether pain interference at time 1 predicts well-being and distress at time 2 when age and physical illness were controlled. In addition, autoregressive paths for HWB, EWB, distress, and pain interference were examined. The unconstrained model, in which all paths were allowed to vary between genders, produced the following results: $\chi^2_{1163} = 2095.80$, $p < .001$; SRMR = 0.08; CFI = 0.92; RMSEA = 0.06, 90% CI [0.05, 0.06]. When this model was compared to the constrained model in which all regression paths and covariances were set to equal across genders, $\chi^2_{1182} = 2127.64$, $p < .001$; SRMR = 0.08, CFI = 0.92; RMSEA = 0.06, 90% CI [0.05, 0.06], the chi-squared difference test produced a significant difference between these models ($\Delta\chi^2_{19} = 31.84$, $p = .033$), indicating that there are significant differences in the regression paths or covariances between genders. To assess which regression paths or covariances should be estimated freely between genders, we conducted a chi-squared difference test. The result indicated that constraining covariances between HWB and distress ($\Delta\chi^2_1 = 9.05$, $p = .003$) and between EWB and distress ($\Delta\chi^2_1 = 10.46$, $p = .001$) led to a significantly worse fit compared to the unconstrained model. All regression paths and other covariances were constrained to be equal across genders. Following these modifications, the final model produced an acceptable model fit ($\chi^2_{1180} = 2116.15$, $p < .001$; SRMR = 0.08, CFI = 0.92; RMSEA = 0.06, 90% CI [0.05, 0.06]), and compared to the unconstrained model, the chi-squared difference test produced a non-significant difference between these models ($\Delta\chi^2_{17} = 20.35$, $p = .257$).

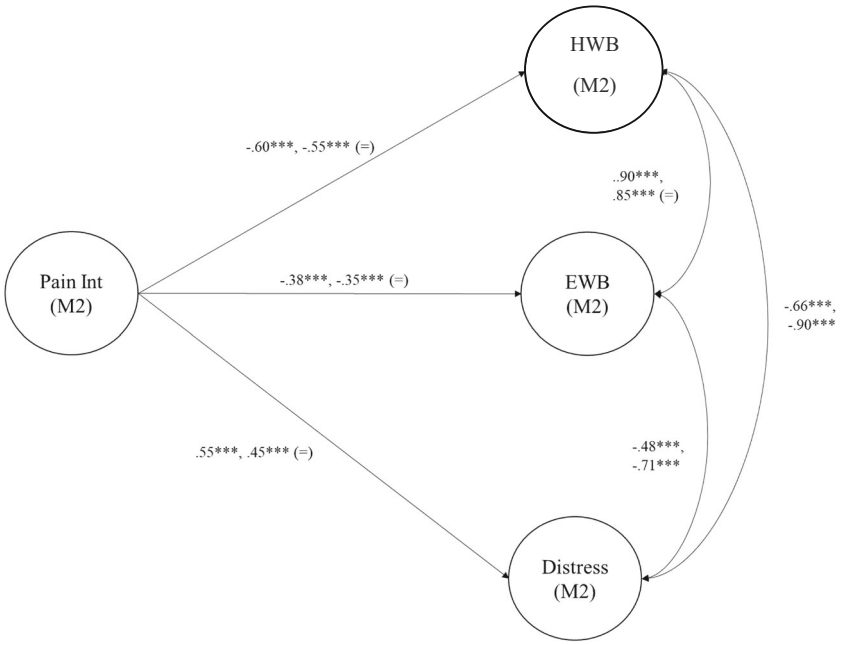

Fig. 1 Chronic pain interference, well-being, and psychological distress in MIDUS-II. All regression paths shown are standardized regression coefficients. Equal mark (=) represents that the paths are constrained to be equal between genders. First values are for male and second values are for female participants. Pain Int pain interference. $\chi^2_{(307)} = 706.346$, $p < .001$, SRMR = 0.070, CFI = 0.920, RMSEA = 0.074 (90% CI [0.067, 0.081]).

All autoregressive paths were significant ($\beta = .54$ to .69, $p < .001$; $\beta = .51$ to .70, $p < .001$ for men and women, respectively). When cross-lagged paths were examined, a significant negative association was found between pain interference at time 1 and EWB at time 2 ($\beta = -0.09$, $SE = 0.04$, $p = .047$; $\beta = -0.08$, $SE = 0.04$, $p = .048$ for men and women, respectively). For both genders, there were significant positive associations between HWB and EWB at time 1 ($r = .92$, $p < .001$; $r = .84$, $p < .001$ for men and women, respectively) and at time 2 ($r = .81$, $p < .001$; $r = .71$, $p < .001$ for men and women, respectively). Negative associations were found between distress and both HWB and EWB for both time 1 and

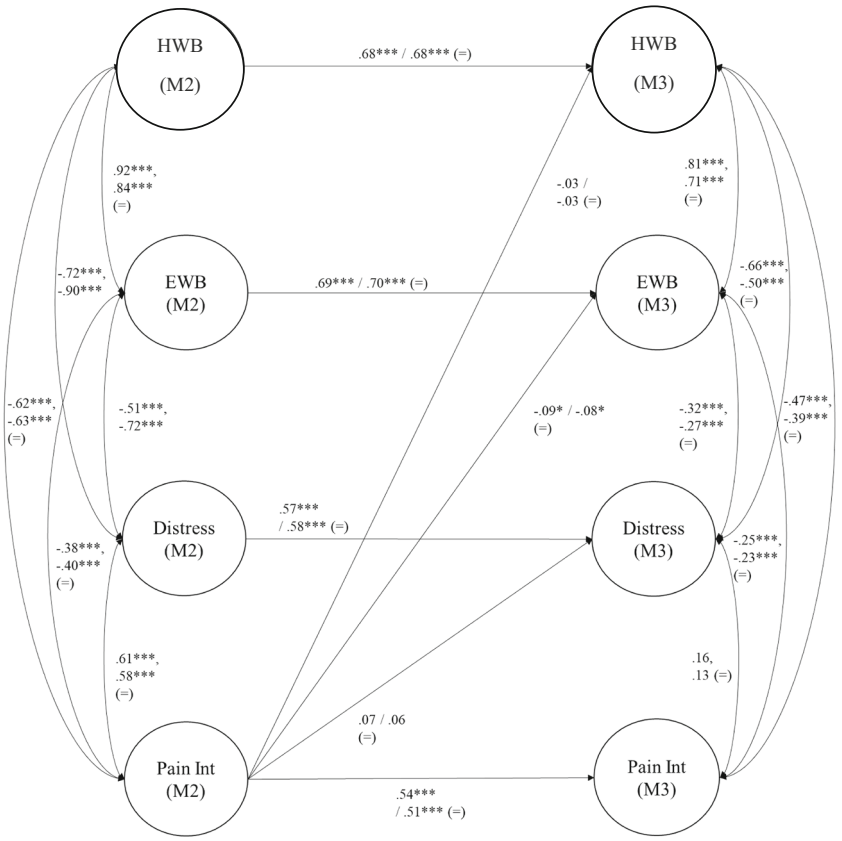

Fig. 2 Longitudinal effects of chronic pain interference on well-being and psychological distress. All regression paths shown are standardized regression coefficients. Equal mark (=) represents that the paths are constrained to be equal between genders. First values are for male and second values are for female participants. Pain Int pain interference. $\chi^2_{(1180)} = 2116.15$, $p < .001$, SRMR = 0.080, CFI = 0.917, RMSEA = 0.058 (90% CI [0.054, 0.062])

time 2 ($r = -.32$ to $-.72$, $p < .001$; $r = -.27$ to $-.90$, $p < .001$ for men and women, respectively). Similar patterns were found between pain interference and both HWB and EWB for both time points ($r = -.25$ to $-.62$, $p < .001$; $r = -.23$ to $-.63$, $p < .001$ for men and women, respectively). For both genders, there were significant negative associations between distress and pain interference at time 1 ($r = .61$, $p < .001$; $r = .58$, $p < .001$ for men and women, respectively); however, at time 2, they were not statistically significant ($r = .16$, $p = .050$; $r = .13$, $p = .052$ for men and women, respectively).

Discussion

The results of our study revealed the concurrent relation between the experience of chronic pain interference and decreased EWB and HWB. More importantly, chronic pain interference at one point in life was predictive of decreased EWB, but not HWB or psychological distress 10 years later. In our first model, concurrent chronic pain interference was related to increased psychological distress and diminished well-being. Specifically, the association between chronic pain interference and HWB was the strongest, followed by psychological distress and EWB. Few studies have examined HWB and EWB and psychological distress among chronic pain patients. However, based on the studies that examined both HWB and psychological distress (depression), one study found similar results in a group of older African Americans [16] in which pain was associated more strongly with life satisfaction, a component of HWB, than with depression [16]. These results point to an important distinction, in that pain is related differently to psychological distress and well-being. This distinction can be used in an intervention in which the goal of pain management includes fostering well-being in addition to ameliorating psychological distress symptoms.

To date, two studies have examined the cross-sectional relation between chronic pain interference and EWB [5, 19], neither of which found an association between the two. One reason for this divergent finding could be that the two studies examined very specific types of chronic pain (i.e., musculoskeletal pain and rheumatoid arthritis), while our study included all types of chronic pain symptoms among adults. Further, their studies were conducted in Italy and UK [5, 19], so cultural differences in chronic pain management and perceptions of chronic pain might have yielded different results. With respect to the measurement of EWB, although Mangelli and colleagues' study included Ryff's measure of psychological well-being [19], which was used in this study as well, Huber and colleagues included items that are not considered EWB typically (e.g., mentally engaged, physically active) [5]. Therefore, differences in the way EWB is measured could limit our understanding of its association with chronic pain.

In our second model, a similar level of stability across the 10-year timespan was found for both EWB and HWB, indicating that both constructs showed comparable levels of stability across time. However, when cross-lagged relations between pain and EWB and HWB were examined, the differential effect of pain on EWB and HWB emerged, such that chronic pain interference at time 1 was not a significant predictor of future HWB or psychological distress, but was a significant predictor of future EWB. One explanation can be attributed to the different natures of HWB and EWB, in that HWB is more short term and EWB more long term [68, 69]. Largely, HWB, which consists of affective well-being, is a situational, transient, or "state-like" well-being [70], because people's positive and negative affect likely fluctuates over the course of a day, week, and month, not to mention year. Thus, experiencing chronic pain interference at some point in one's life would not necessarily have a lasting effect on HWB 10 years later. On the other hand, because EWB consists of such constructs as autonomy, relationships with others, purpose in life, personal growth, environmental mastery, and self-acceptance, which are "trait-like" and associated with deep-seated values [69], EWB is likely to persist over time. For example, when people suffer from chronic pain, the amount and types of interactions they have with their family and friends may change, leading to strain in the relationships. In addition, when behaviors shift to cope with pain and accommodate pain sufferers, both parties' identity change [71]. Once the dynamics of the relationship is altered and "pain identities" are formed, even if pain is alleviated in the course of 10 years, the pain sufferers, as well as those around them, might cling to the "new normal" that developed as a result of the chronic pain. Consequently, this makes it difficult to return to, and engage in, former relationship dynamics. The key to our purpose here is that once pain sufferers undergo a shift in their identity, they are not likely to revert to their previous selves. Therefore, once the shift has taken place, elements related to EWB, such as purpose in life, autonomy, and environmental mastery are never the same. In short, HWB is concerned with events that contribute to "how one is doing" on a given day, while EWB is concerned with one's values that contribute to "who they are." Because of these differences, people with chronic pain at any point in their lives are at greater risk of losing these important elements that constitute who they are.

Overall, our results suggested that chronic pain assessed at a single time may be predictive of future EWB, even 10 years later. This significant association between chronic pain and well-being has a clinical implication in targeting well-being as a resilience factor among chronic pain patients, as well as discussing chronic pain interference's possible lasting effect on people's sense of autonomy, environmental mastery, personal growth, positive relationships, purpose in life, and self-acceptance. All of these factors are critical to what makes life worth living but have been neglected acutely in research and

practice with chronic pain patients. This study challenges us to expand our understanding of the ways in which chronic pain affects people's psychological functioning, particularly with respect to EWB.

Our findings highlight chronic pain's role in people's well-being. Many medical and behavioral treatments for chronic pain tend to focus on alleviating psychological distress or the *absence of something negative*. In contrast, our results can be used to develop interventions that are based on positive psychology frameworks, such as the *presence of something positive*, thereby helping individuals thrive and flourish [72] despite their pain, rather than simply survive the chronic pain. Studies have indicated that well-being can be "induced and heightened" over time through deliberate interventions [73]. Clinicians who work with pain sufferers can use forms of therapy positive psychology informs as the primary treatment method or to augment treatment-as-usual. Such forms of therapy in the literature include Strengths-Based Counseling [74], Strengths-Centered Therapy [75], Quality of Life Therapy [76], Well-being Therapy [77], Hope Therapy [78], and Positive Psychotherapy [79].

Emerging literature has examined the efficacy of positive psychology interventions in patients with chronic pain [80–83]. The four available studies in this line of research used predominantly computer or phone-based interventions, whereas only two of the four studies included one in-person baseline visit. The results generally supported the efficacy of the positive psychology intervention. For example, in a randomized clinical trial study to test the efficacy of a computer-based positive psychology intervention among people with chronic pain and a physical disability, results favoring the treatment group emerged relative to a neutral control condition [80]. Results from another study suggested a slight advantage of an internet-based positive psychology intervention over internet-based cognitive behavioral therapy in patients with a higher education [81]. Using a telephone-administered intervention with one in-person baseline visit, one study, with a sample of 42 patients and a 3:1 ratio of patient to staff, found that patients in the positive psychology intervention group reported significantly more improvement compared to the control group [83]. Using the same modality, another study, with a sample of 360 patients, found no improvement in chronic pain or functional difficulty, indicating that the stand-alone positive psychology intervention was not effective. While a larger sample generally allows for more accurate results, the "patient to staff ratio" was not included in the second study, making it difficult to evaluate the context of the intervention that was provided for the patients. We are left to wonder, therefore, if the ratio of patient to staff might have been greater than 3:1. If that was the case, the staff might have felt the need to rush through their follow-up phone assessments. Perhaps this differed from the first study with the smaller sample. If participants were rushed through their assessments, they might have felt dismissed or insignificant, which may have negatively influenced the efficacy of such interventions. This point is especially noteworthy because one of the six modules of the intervention, which was concerned with gratitude, could have been rendered less effective if participants felt dismissed. We encourage future researchers to consider the effect of "patient to staff" ratio on treatment efficacy. This line of research also needs to be further developed using an in-person intervention to elucidate the mixed results from the computer or phone-based intervention. While there is some initial evidence for the efficacy of the positive psychology intervention, existing studies suggest that, rather than being a stand-alone intervention, a positive psychology intervention may best be used as an add-on to an existing and more established treatment [81].

Thus, we encourage researchers to consider examining pain sufferers' positive psychological functioning, in addition to addressing and alleviating their psychological distress so that such an inquiry can be used in interventions in which clinicians help facilitate pain sufferers' resilience and self-efficacy in reducing negative outcomes. One measure of resilience is optimal well-being, which encompasses autonomy, purpose in life, personal growth, positive relationships with others, environmental mastery, self-acceptance, and life satisfaction, as well as increased emotional well-being. Specifically, given chronic pain's effect on EWB, our results support psychological interventions for chronic pain that are based on values, such as Acceptance and Commitment Therapy (ACT).

While this study has several strengths, including its longitudinal examination of both EWB and HWB, as well as the use of structural equation modeling to model pain interference's effects on the longitudinal course of well-being and psychological distress, it is not without limitations. Although our study used the Brief Pain Inventory (BPI) [33] to assess pain interference, we relied on a single retrospective question to assess the frequency of chronic pain conditions. Future studies would benefit from adding a well-validated clinical interview, as well as measuring pain duration and intensity. Further, we measured pain interference two times 10 years apart and no data were collected between. Thus, it is difficult to assess whether chronic pain interference reported at times 1 and 2 were two singular events or ongoing chronic pain conditions. More frequent measures, including a within-subjects design, such as an ecological momentary assessment, would allow more sensitive assessments and allow more wide-ranging and detailed measurements of well-being.

Our results add to the literature on the association between pain and psychological functioning, in that chronic pain interference affects people's current and future psychological well-being, as well as psychological distress. Specifically, this study highlighted that people with chronic pain are particularly susceptible to diminished EWB in the future, and thus

future researchers are encouraged to examine possible mechanisms of the way that chronic pain affects people's HWB and EWB differently. We also recommend that clinicians consider that there is more to living well or actualizing one's human potential than people's reports of depression, positive affect, and life satisfaction. Our study supports the relevance and importance of the concept of well-being in the experience of chronic pain and has the potential to encourage the use of a positive psychological framework to guide chronic pain treatment and prevention strategies.

Compliance with Ethical Standards

The study received ethical approval from the Institutional Review Board at the University of Wisconsin-Madison.

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with human participants performed by any of the authors.

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