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ORIGINAL ARTICLE

# Modeling subjective well-being in individuals with chronic pain and a physical disability: the role of pain control and pain catastrophizing

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**ABSTRACT**

**Purpose:** To investigate the associations between subjective well-being and pain intensity, pain interference, and depression in individuals with physical disabilities. We hypothesized that (1) pain control and (2) pain catastrophizing mediate the effects of subjective well-being on pain intensity, pain interference, and depression.

**Methods:** Analyses of cross-sectional data from 96 individuals diagnosed with spinal cord injury, multiple sclerosis, neuromuscular disease, or post-polio syndrome, with average pain intensity of $\geq$4 (0–10) on at least half the days in the past month. Two models tested study hypotheses using structural equation.

**Results:** Both models showed acceptable model fit. Pain catastrophizing significantly mediated the effect of subjective well-being on pain intensity and pain interference, but not on depression. Pain control did not significantly mediate the effect of subjective well-being on pain intensity, pain interference, or depression. Path coefficients showed significant direct effects of subjective well-being on pain control ($\beta = 0.39$), pain catastrophizing ($\beta = -0.61$), pain interference ($\beta = -0.48$; $-0.42$), and depression ($\beta = -0.75$; $-0.78$).

**Conclusions:** This study supports the potential of enhancing subjective well-being and lowering pain catastrophizing for reducing pain intensity, pain interference, and depressive symptoms in individuals with chronic pain and a physical disability. The findings indicate that true experiments to test for causal associations are warranted.

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**KEYWORDS**
Subjective well-being; chronic pain; pain catastrophizing; pain control; pain interference; depression

➤ **IMPLICATIONS FOR REHABILITATION**

- The majority of individuals with physical disabilities report having persistent moderate-to-severe pain that may negatively limit daily activities and quality of life.
- The present cross-sectional study indicates that individuals who reported greater subjective well-being showed significantly lower pain intensity via the mediating effect of lower pain catastrophizing.
- Since sample size and respective power are low, these findings should be taken as first indications of potential underlying mechanisms between subjective well-being and pain outcomes that need further confirmation in longitudinal research.
- However, the findings suggest that treatments which enhance subjective well-being (increasing positive affect and life satisfaction, and decreasing negative affect, e.g., via positive psychology exercises) and reducing pain catastrophizing (via e.g., cognitive-behavioral therapy) may have the highest potential for benefiting individuals with disability-associated chronic pain.



## Introduction

Chronic pain is a widespread problem linked to a number of negative consequences. Nearly one in three adults in the United States [1] and one in five adults in Europe [2] experience chronic moderate-to-severe pain. In individuals with a physical disability, chronic pain is even more frequent. Prevalence rates of chronic pain vary depending on type of health condition and pain etiology, with estimates ranging from 44% to 80% in individuals with multiple sclerosis (MS) [3], approximately 80% in individuals with a spinal cord injury (SCI) [4], 73% in individuals with neuromuscular disease (NMD) [5] and about 91% in individuals with post-polio syndrome (PPS) [6]. Moreover, chronic pain is consistently found to be associated with a person's physical, psychological, and social functioning. In particular, chronic pain has been found to be linked to poorer general health, limitation in activities of daily living [7], higher risk for the development of depressive disorders [7–9], less social integration [9], and lower quality of life [8].

Current treatments for chronic pain are based on a biopsychosocial framework and include pharmacological, non-pharmacological, and psychological approaches. Of these, pharmacological treatments are most frequently used [10]. In addition to significant treatment side-effects, evidence from clinical trials show that pharmacological treatment is in most cases unsatisfactory, since a 50% pain reduction is only achieved in 30% of individuals with chronic pain [11,12]. Non-pharmacological interventions, such as acupuncture or physiotherapy and psychological treatment are therefore increasingly being used as an adjunct to pharmacological treatment [13]. Traditional psychological treatment (e.g., cognitive behavioral therapy) focuses on changing maladaptive

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pain-related beliefs and behavioral patterns [14]; alternatively, so-called positive psychology interventions focus on enhancing an individual's strengths and resources (e.g., optimism, gratitude, social relations, and kindness) to increase subjective well-being (i.e., satisfaction with life and a predominance of experiencing positive compared to negative affect [15]).

A recent randomized controlled trial provided evidence for the efficacy of positive psychology interventions in individuals with chronic pain secondary to a physical disability [16]. The study showed that practicing different positive psychology exercises significantly increased subjective well-being and decreased depressive symptoms. Participants also reported an increase in pain control, and a reduction in pain intensity, pain interference, and pain catastrophizing (i.e., negative cognitive and emotional reactions in response to pain [17]). In addition to research on the efficacy of chronic pain treatments, a number of studies have demonstrated the influence of pain control and pain catastrophizing on pain intensity, pain interference and depressive symptoms [7,9,18,19]. In addition, life satisfaction has been found to be associated with lower pain intensity and less depressive symptoms in individuals with chronic pain and physical disabilities [20]. It has also been found that positive and negative affect influence pain outcomes [21]. In particular, pain engenders negative affect, and negative affect, in turn can exacerbate pain and may negatively impact psychological function (e.g., depressive symptoms), social and physical function (e.g., pain interference) as hypothesized by the fear-avoidance model [22], illness behavior model [23], and model of disability [24]. Positive affect, found in high subjective well-being, however, has been found to lead to lower pain in experimental studies, suggesting that positive affect can be analgesic [21,25]. Among pain outcomes, studies showed that higher pain intensity is related to increased pain interference [19], and both are related to increased depressive symptoms [18]. Therefore, it is reasonable to hypothesize that individuals with chronic pain and higher subjective well-being (higher life satisfaction and higher positive affect) would evidence better pain outcomes through the effects of cognitive and emotional responses to pain.

Although the extant research suggests that positive psychology treatments and variables may play an important role in adjustment to chronic pain, there remains limited research in this area. In order to help inform the development of more effective psychological treatments for chronic pain in individuals with a physical disability, a better understanding of the mechanism underlying the association between subjective well-being and pain outcomes is needed. The aim of the present study was to address this knowledge gap by evaluating the mediating role of two psychological variables in the association between subjective well-being and three key pain outcomes in individuals with chronic pain and a physical disability. Specifically, this study hypothesized that (1) pain control and (2) pain catastrophizing mediate the effect of subjective well-being on pain intensity, pain interference, and depression.

## Materials and methods

This study includes analyzing cross-sectional data collected between March 2013 and February 2014 from 96 individuals living in the community and diagnosed with different physical disabilities. Participants were recruited from a rehabilitation medicine registry of individuals with physical disabilities primarily living in the north-western USA and willing to consider participating in research studies. Eligible participants were persons 18 years of age or older who were diagnosed with a physical disability (i.e., MS, SCI, NMD, or PPS) and experiencing chronic pain (i.e., average disability-related pain intensity of $\geq$4 on a 0–10 numeric rating scale in the past week, at least half the days in the last 4 weeks). Participants had also to be able to understand and complete online questionnaires (i.e., able to speak, read and write English and have weekly internet access for at least 30 min). Individuals who had received any form of psychotherapy once or more often in the past month, were admitted to a hospital for psychiatric reasons within the past year, or evidenced cognitive impairment (specified as having one or more errors on the Six-Item Cognitive Impairment Test [26] were excluded from the study (Figure 1).

### Study procedure

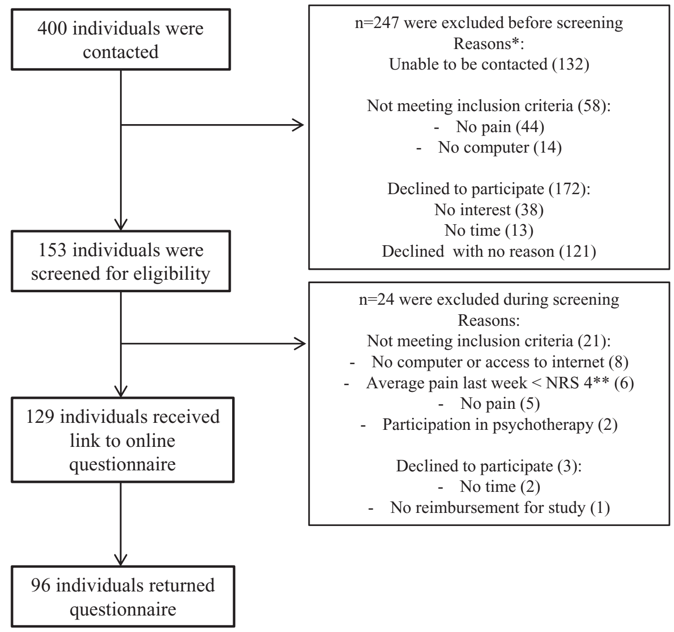
Information about the study and consent information statement were sent by post to a random selection of 100 individuals from each of the four diagnosis ($N = 400$) who were registered in the research database. Invited participants were informed to contact the principle investigator (last author) if they were interested in participating, and, if they did not respond, would be contacted by the principle investigator by telephone in about 2–3 weeks. All potential participants were screened by telephone for eligibility using a recruitment script. Eligible individuals were asked to give informed consent statement. In case of consent, the authors sent a link for the online questionnaire to the participants. The study procedures were approved by the Institutional Review Board committee at the local university and in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments.

Study invitation letters were sent out to 400 potentially eligible individuals. To test the study hypotheses a sample size of at least 70–140 participants is necessary (see also analysis section). Response rate to the study information letter was 38% ($n = 153$). Of these, 129 individuals (84%) met eligibility criteria and consented to participate. The questionnaire was completed and returned by 74% of eligible individuals ($n = 96$) (Figure 1). Table 1 shows the study characteristics of the total sample and each disability group. The study population included 70% women ($n = 67$) and 30% men ($n = 29$). The mean age was 59 years with a range from 24 to 81 years. In the present sample, 27% were diagnosed with MS ($n = 26$), 25% with SCI ($n = 24$), 29% with NMD ($n = 28$), and 35% with PPS ($n = 34$). The mean time since injury or diagnosis was 23 years. Regarding type of pain (assessed via PainDETECT [27]), 46% were classified as having nociceptive pain ($n = 44$), 25% were classified as having neuropathic pain ($n = 24$) and 28% were classified as having an unclear pain type ($n = 27$).

### Outcome measures

*Pain intensity* was measured using the Numerical Rating Scale (NRS). Participants were asked to rate the average intensity of pain they experienced in the past week on a 0–10 point scale (0 *No pain* to 10 *Worst pain*). The NRS has been shown to be reliable and valid in measuring pain intensity [28]. It is recommended as a core outcome measure of pain intensity in research [29].

*Pain interference* was assessed using a 12-item version of the Pain Interference Scale adapted for individuals with physical disabilities [30]. The Pain Interference scale is a subscale from the Brief Pain Inventory (BPI) [31]. Participants were asked to rate the extent their pain interfered with different daily activities (e.g., mobility, social activities, work, and sleep) in the past week on a 0–10 point Likert scale (0 *Does not interfere* to 10 *Completely interferes*). Higher scores indicate higher pain interference. Reliability




Note: * Total sum > 100% because persons gave more than one reason.
** NRS = Numeric Rating Scale (0-10) to asses pain intensity.

**Figure 1.** Participants' flow diagram.



and validity in measuring pain interference in individuals with a physical disability are supported [30]. In the current study, Cronbach's alpha was excellent (α = 0.92).

*Depressive symptoms* were measured using the 7-item Depression subscale of the Hospital Anxiety and Depression Scale (HADS-D) [32]. Participants were asked to rate the frequency or severity of each of seven symptoms during the past week on a 4-point scale (e.g., 3 *Often* to 0 *Very seldom* or 0 *Definitely as much* to 3 *Hardly at all*). Higher scores indicate higher frequency or greater severity of depressive symptoms. The HADS-D has been shown to be reliable and valid in measuring depressive symptoms in individuals with a disability [33]. In the current study, the internal consistency (Cronbach's alpha) of the HADS-D was good (α = 0.81).

### Subjective well-being measures

*Subjective well-being* was assessed as a construct of life satisfaction, positive affect and negative affect. This is based on the Diener's theoretical concept of subjective well-being [15]. A Principle Component Analysis was performed to determine if these three scales (life satisfaction, positive affect, and negative affect) adequately measured the latent variable of subjective well-being. Results showed that the observed variables explained about 70% of the variance of subjective well-being, with acceptable loadings for life satisfaction (0.61), positive affect (0.58), and negative affect (−0.54). Thus, the results confirm unidimensionality of the latent variable subjective well-being.

*Life satisfaction* was assessed using the Personal Wellbeing Index – Adult version [34] (PWI-A). It assesses overall life satisfaction and satisfaction with specific life domains (e.g., health, achievement, relationships, and future security). Responses to nine items are given on a 0–10 point rating scale (0 *Completely dissatisfied* to 10 *Completely satisfied*). Higher scores indicate higher life satisfaction. The PWI-A has been shown to be a reliable and valid measure of life satisfaction [35]. In the current sample, the Cronbach's alpha was good (α = 0.89).

*Positive and Negative Affect* were measured using the Positive and Negative Affect Schedule (PANAS) [36]. The PANAS assesses positive affect (PA) (e.g., "excited", "inspired") and negative affect (NA) (e.g., "scared", "ashamed") in the past week and includes 20 items with response options on a 5-point Likert scale (1 *Very slightly or not at all* to 5 *Extremely*). Higher scores represent higher level of positive and negative affect, respectively. The PANAS has considerable evidence supporting its validity and reliability in measuring positive and negative affect [37]. In the current sample, the Cronbach's alphas for both scales were good: PA (α = 0.89) and NA (α = 0.89).

### Measures of mediators

*Pain control* was measured using the Survey of Pain Attitudes (SOPA) Pain Control subscale [38] which assesses the extent to which someone believes he/she is able to control their pain. It includes 10 items with response options on a 5-point Likert scale (1 *This is very untrue for me* to 5 *This is very true for me*). Higher scores represent higher perceived control over pain. The SOPA scales, including the Pain Control scale, have been shown to be reliable and valid measures of pain beliefs in individuals with a physical disability and chronic pain [38,39]. In the current sample, the internal consistency of the measure was good (α = 0.84).

*Pain catastrophizing* was measured using the Pain Catastrophizing Scale (PCS) [40], which assesses three domains of pain-related catastrophizing – rumination, helplessness, and magnification. It includes 13 items with response options indicating the frequency of catastrophizing on a 5-point Likert scale (1 *Not at all* to 5 *All the time*). Participants were asked to rate each statement about their thoughts and feelings linked to the experience of pain. Higher scores indicate more pain catastrophizing. The PCS has been shown to be reliable and valid in measuring pain

Table 1. Descriptive characteristics of study population ($n = 96$).

| | *n* (%) | MS[a] (%) | SCI[a] (%) | NMD[a] (%) | PPS[a] (%) |
|---|---|---|---|---|---|
| Total | 96 (100.0) | 26 (27.1) | 24 (25.0) | 28 (29.2) | 34 (35.4) |
| Gender | | | | | |
| Male | 29 (30.2) | 6 (23.1) | 17 (70.8) | 7 (25.0) | 6 (17.6) |
| Female | 67 (69.8) | 20 (76.9) | 7 (29.2) | 21 (75.0) | 28 (82.4) |
| Age mean in years, SD [range] | 59.4, 11.8 [24–81] | 56.7, 11.2 [24–75] | 54.5, 11.4 [27–72] | 58.5, 11.5 [37–76] | 67.7, 6.1 [57–81] |
| Relationship status | | | | | |
| Single | 29 (30.2) | 5 (19.2) | 12 (50.0) | 7 (25.0) | 12 (35.3) |
| In a relationship | 67 (69.8) | 21 (80.8) | 12 (50.0.) | 21 (75.0) | 22 (64.7) |
| Ethnicity* | | | | | |
| Caucasian | 92 (95.8) | 23 (88.5) | 23 (95.8) | 27 (96.4) | 33 (97.1) |
| American Indian/Alaska Native | 2 (2.1) | 0 (0.0) | 1 (4.2) | 0 (0.0) | 1 (2.9) |
| Asian | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Black/African American | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Native Hawaiian/other Pacific Islander | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Hispanic/Latino | 1 (1.1) | 1 (3.8) | 0 (0.0) | 1 (3.6) | 0 (0.0) |
| Other | 4 (4.2) | 3 (11.5) | 0 (0.0) | 1 (3.6) | 0 (0.0) |
| Missing | 3 (3.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Education mean in years, SD [range] | 5.8, 1.1 [3–7] | 6.04, 1.0 [4–7] | 5.88, 0.9 [3–7] | 5.64, 1.1 [3–7] | 5.8, 1.2 [3–7] |
| Employment* | | | | | |
| Full-time | 8 (8.3) | 4 (15.4) | 0 (0.0) | 4 (14.3) | 0 (0.0) |
| Part-time | 9 (9.4) | 1 (3.8) | 1 (4.2) | 3 (10.7) | 4 (11.8) |
| Attending school/voc. training full-time | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Attending school/voc. training part-time | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Retired | 45 (46.9) | 11 (42.3) | 10 (41.7) | 10 (35.7) | 23 (67.6) |
| Homemaker | 4 (4.2) | 0 (0.0) | 1 (4.2) | 2 (7.1) | 1 (2.9) |
| Unemployed due to pain | 5 (5.2) | 1 (3.8) | 3 (12.5) | 2 (7.1) | 2 (5.9) |
| Unemployed due to disability | 35 (36.5) | 11 (42.3) | 12 (50.0) | 8 (28.6) | 10 (29.4) |
| Unemployed for other reasons | 6 (6.3) | 1 (3.8) | 3 (12.5) | 1 (3.6) | 1 (2.9) |
| Time since injury/diagnosis mean in years, SD [range] | 23.0, 14.9 [2–70] | 17.2, 9.6 [2–42] | 26.5, 17.3 [3–70] | 28.0, 18.9 [6–70] | 20.3, 10.7 [3–64] |
| Pain type | | | | | |
| Nociceptive pain | 44 (45.8) | 6 (23.1) | 8 (33.3) | 15 (53.6) | 22 (64.7) |
| Neuropathic pain | 24 (25.0) | 10 (38.5) | 6 (25.0) | 8 (28.6) | 8 (23.5) |
| Unclear | 27 (28.1) | 9 (34.6) | 10 (41.7) | 5 (17.9) | 4 (11.8) |
| Missing | 1 (1.0) | 1 (3.8) | 0 (0.0) | 0 (0.0) | 0 (0.0) |

[a]Total sum greater than 100% because respondents were allowed to select more than one answer.
MS: multiple sclerosis; SCI: spinal cord injury; NMD: neuromuscular disease; PPS: post-polio syndrome.

catastrophizing [41–43]. In the current sample, the internal consistency of the measure was excellent ($\alpha = 0.91$).

### *Descriptive measures*

This study assessed the *socio-demographic* variables of gender, relationship status, ethnicity, employment status, age, and education. Information on *disability type* (MS, SCI, NMD, and PPS) was extracted from the research database. In addition, date of injury or date of first diagnosis of the disability was assessed. *Pain type (*nociceptive, neuropathic, and unclear) was measured using the painDETECT questionnaire (PD-Q) [27]. The PD-Q assesses nine pain qualities thought to represent neuropathic pain. First, participants select one of four pain temporal patterns (e.g., persistent pain with slight fluctuations, pain attacks without pain between) that best describes their pain. The other items assess the severity of eight pain quality descriptors (e.g., "burning", "pressure", "radiate") with response options on a 6-point Likert scale (*Never* to *Very strongly*). A total score of $\leq$12 indicates that neuropathic pain is unlikely and a total score of $\geq$19 indicates that neuropathic pain is likely to be present. The scores between these cutoffs indicate "unclear" pain type. The PD-Q has been shown to be reliable and valid to screen for neuropathic pain in individuals with back pain [27].

### *Analysis*

Statistical analyzes were performed in Stata 13.1 and the statistics environment "R" [44] and its "lavaan" (Latent Variable Analyses) package (version 3.0.1) [45]. Different pain models and previous research in individuals with chronic pain and physical disabilities were used as conceptual framework to specify two models. Model 1 (Figure 2) hypothesizes that pain control mediates the relationship between subjective well-being and pain intensity, pain interference, and depression. Model 2 (Figure 3) hypothesizes that pain catastrophizing mediates the relationship between subjective well-being and pain intensity, pain interference, and depression.

Both of the two models tested subjective well-being specified as a latent variable and estimated by the three observed variables (i.e., indicators) life satisfaction, positive affect, and negative affect. The models were tested using structural equation modeling (SEM). SEM is a statistical method which aims to investigate how well a complex theoretical model is explained by the sample data [46]. It provides an understanding of a complex theoretical model and allows examining relationships among and between different variables [46]. SEM results can be used to identify potential treatment and intervention targets that can be evaluated in subsequent experiments [47]. SEM combines factor analysis and path analysis. Factor analysis is applied to build measurement models which describe how unobserved latent variables are measured by observed variables (e.g., in this case, subjective well-being) [47]. Path analysis is applied in structural models to examine relationships between different observed and latent variables (e.g., in this case, the relation between subjective well-being and pain intensity) [47].

One requirement for SEM is a sufficiently large sample size. Guidelines propose to include 10–20 participants per indicator [47]. In this study, seven indicators were included in each model, indicating a need for a sample size of at least 70–140 participants.

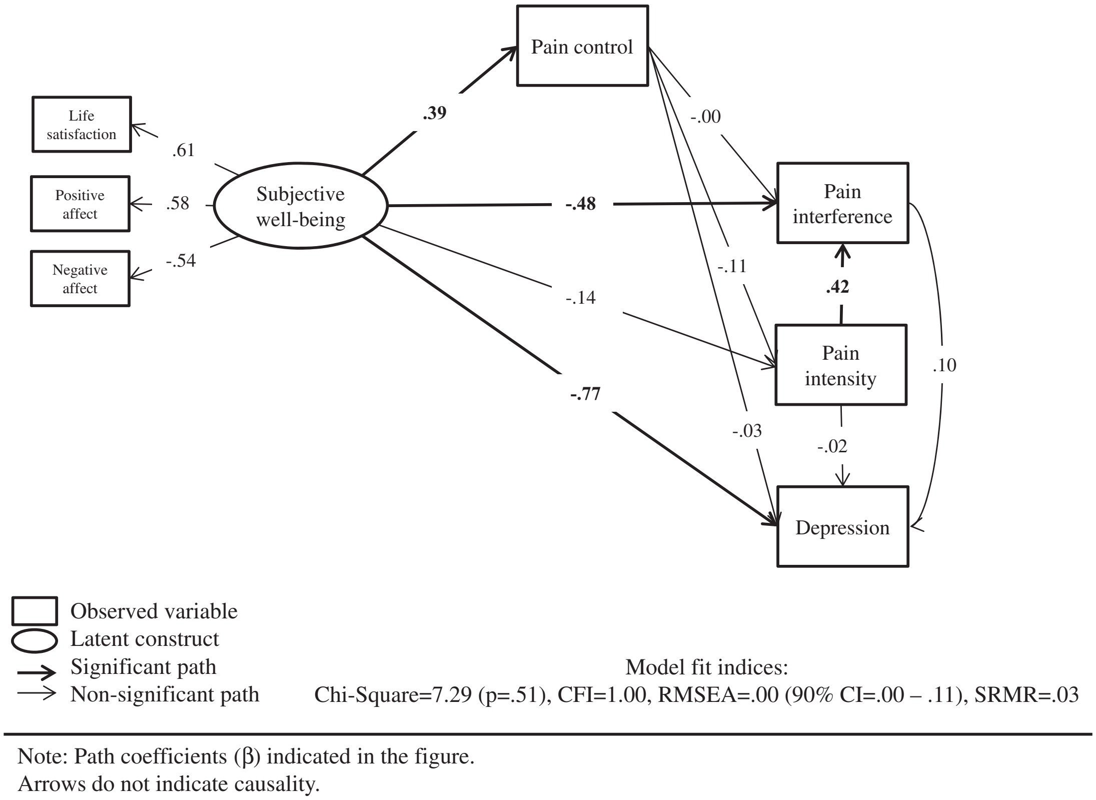



**Figure 2.** Model 1 with the mediating variable "Pain control".

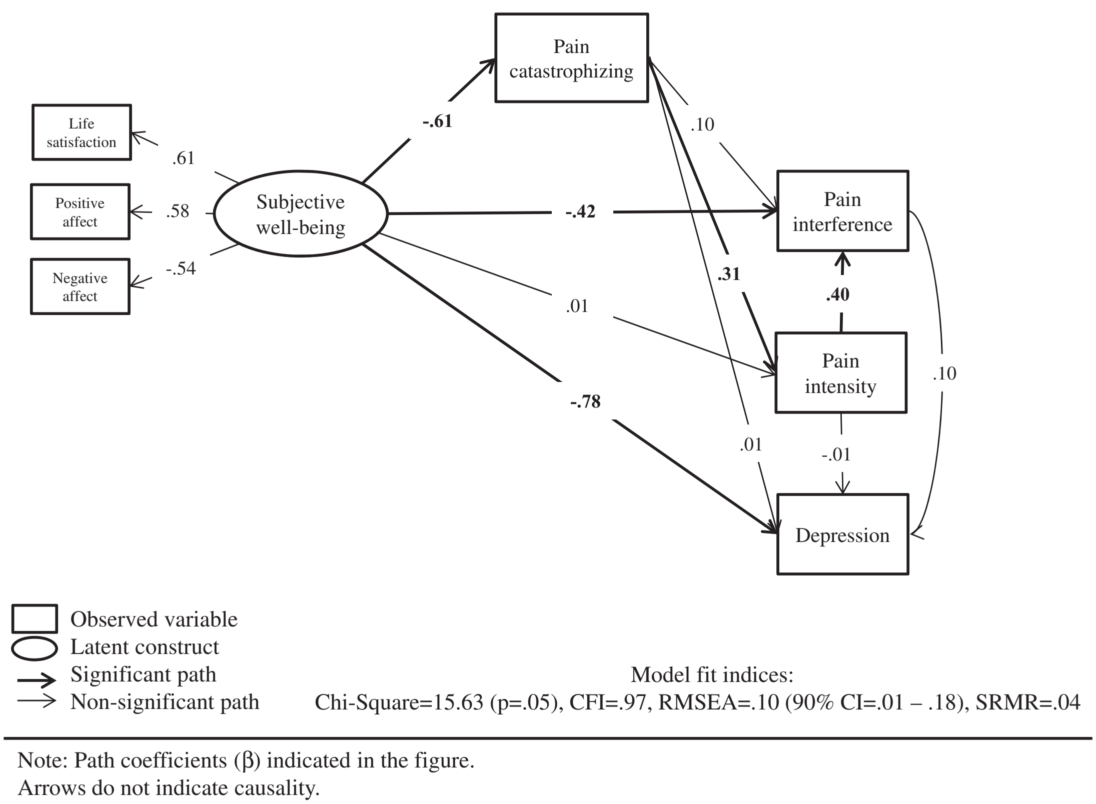



**Figure 3.** Model 2 with the mediating variable "Pain catastrophizing".

The present sample included $n = 96$ individuals, which is relative small but acceptable for testing for the two hypothesized models. Another requirement of SEM is a normal distribution of the data [47]. To test for this assumption, the distribution of each observed variable was examined for skewness and kurtosis (univariate distribution) [47]. Absolute values of skewness $\leq 2$ and absolute values of kurtosis $\leq 7$ were judged to be normally distributed and fulfill the requirements needed to conduct SEM [48,49]. A final requirement in SEM is no multicollinearity among the observed variables [47]. To test for this, bivariate correlations were computed, with Pearson's correlations $\leq 0.85$ judged to indicate no potential problems concerning multicollinearity [49]. As the development and type of pain differ among diagnoses [50], adjustments for potential confounding effects of the different disability types on the outcome variables were addressed to ensure that collapsing data across disability diagnostic groups was appropriate. Therefore, partial correlations were conducted to control for disability diagnosis and the correlation coefficients for between-group differences were examined. Differences less than 0.10 were considered as a negligible confounding effect. In addition, analyzes of variance (ANOVA) were conducted to further examine potential differences in pain outcomes (pain intensity, pain interference, pain catastrophizing, and pain control) and depression as a function of disability diagnostic group. Due to multiple group comparison a Bonferroni corrected significance level of $0.05/4 = 0.0125$ was used.

Models were estimated using robust Maximum Likelihood [47,51] which takes potential violations of data distributions within the recommended range in skewness and kurtosis into account, and corrects for non-normality-induced bias in the standard errors [52]. Overall model fit was evaluated using a number of fit indices. The Chi-Square test assesses model misspecification [47,51] where a significant Chi-Square indicates that the model does not fit the observed data. Thus, acceptable model fit is defined as having a non-significant Chi-Square ($p \geq 0.05$) [47]. Comparative Fit Index (CFI) was used as an incremental fit index, with CFI $\geq 0.90$ indicating acceptable model fit [53]. To account for sample size and model complexity Root Mean Square Error of Approximation (RMSEA) was calculated. RMSEA $\leq 0.10$ with an upper bound of the 90% CI of $\leq 0.10$ indicates acceptable model fit [54]. Finally, we calculated the Standardized Root Mean Square Residual (SRMR), which assess the sum (mean) difference between the observed correlations and the correlations implied in the model. A mean of zero indicates no difference, thus perfect model fit. SRMR $\leq 0.10$ indicates acceptable model fit [55]. To evaluated the relationship between individual variables in the model, standardized estimates for path coefficients were calculated which were interpreted as regression coefficients ($\beta$) [47]. Values around 0.10 indicate a weak relationship, 0.30 a medium strong and values greater than 0.50 a strong relationship [56]. To evaluate the presence of mediation, significance of this indirect relationship was tested, applying a significance level of $\alpha \leq 0.05$. In order to determine power to detect model misspecification in terms of RMSEA Model 1 and 2 were evaluated applying post-hoc analyzes in R [57] taking degrees of freedom (df $= 9$) and sample size ($N = 96$) into account.

## Results

### *Descriptive results*

The range, mean, standard deviation, skewness and kurtosis of outcome variables, subjective well-being, and potential mediating variables are shown in Table 2. Pearson's correlations between outcome variables, subjective well-being, and mediating variables were $<0.85$ indicating no potential problems concerning multicollinearity in both models (Table 3). The mean differences of the correlation coefficients were all $<0.07$ indicating that confounding effects of the disability types were negligible. Comparing the means of all pain outcomes and depression across disability diagnostic groups indicated no significant between group differences.

### *Structural equation modeling*

Model 1 (Figure 2) examined the relationship between subjective well-being and pain intensity, pain interference, and depression, including the variable pain control as a potential mediator. Model 1 showed an acceptable overall model fit with a non-significant Chi-Square of 7.29 ($p = 0.51$), a CFI of 1.00, a RMSEA of 0.00 (90% CI $= 0.00$–$0.11$) and a SRMR of 0.03. Pain control did not significantly mediate the association of subjective well-being with pain intensity ($\beta = -0.04$, $p = 0.387$), pain interference ($\beta = 0.00$, $p = 0.993$), or depression ($\beta = -0.01$, $p = 0.693$). Direct path coefficients showed a significant relationship of subjective well-being with pain control ($\beta = 0.39$, $p < 0.001$), pain interference ($\beta = -0.48$, $p < 0.001$), and depression ($\beta = -0.77$, $p < 0.001$) but no significant relationship with pain intensity ($\beta = -0.14$, $p = 0.273$).

Model 2 (Figure 3) indicates the relationship between subjective well-being and pain intensity, pain interference, and depression, including pain catastrophizing as a potential mediating variable. Model 2 showed an acceptable overall model fit with a non-significant Chi-Square of 15.63 ($p = 0.05$), a CFI of 0.97, a RMSEA of 0.10 (90% CI $= 0.01$–$0.18$) and a SRMR of 0.04. Pain catastrophizing significantly mediated the association of subjective well-being with pain intensity ($\beta = -0.20$, $p < 0.05$) but did not significantly mediate the association of subjective well-being with pain interference ($\beta = -0.06$, $p = 0.327$) and depression ($\beta = -0.01$, $p = 0.912$). However, the relationship of subjective well-being with pain interference was significantly mediated together by pain catastrophizing and pain intensity ($\beta = -0.08$, $p < 0.05$). Direct path coefficients showed significant negative associations of subjective well-being with pain catastrophizing ($\beta = -0.61$, $p < 0.001$), pain interference ($\beta = -0.42$, $p < 0.001$), and depression ($\beta = -0.78$, $p < 0.001$) but no significant association with pain intensity ($\beta = 0.01$, $p = 0.939$).

Regarding the relationships between the outcome variables, results indicated significant direct associations of pain intensity with pain interference in both models ($\beta = 0.40$; 0.42, $p < 0.001$)

**Table 2.** Descriptive characteristics of outcome measures, subjective well-being measures, and mediating measures ($n = 96$).

| Variable (measure) | Range | Mean | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|
| Outcome variables | | | | | |
| Pain intensity (NRS) | 3–10 | 6.7 | 1.6 | −0.19 | 2.36 |
| Pain interference (PIS) | 14–121 | 68.6 | 25.2 | −0.11 | 2.27 |
| Depression (HADS)[a] | 1–18 | 5.9 | 3.5 | 0.87 | 4.10 |
| Subjective well-being | | | | | |
| Life satisfaction (PWI-A) | 21–97 | 65.9 | 16.4 | −0.32 | 2.39 |
| Positive Affect (PANAS) | 15–50 | 32.5 | 7.3 | −0.15 | 2.79 |
| Negative Affect (PANAS) | 10–39 | 17.8 | 6.7 | 1.11 | 3.44 |
| Mediating variables | | | | | |
| Pain control (SOPA) | 10–49 | 28.5 | 7.9 | −0.14 | 2.85 |
| Pain catastrophizing (PCS) | 13–50 | 24.5 | 8.4 | 1.10 | 3.57 |

[a]Three missing values for sum score "Depression" because HADS-Questionnaire was not completed by three individuals.

NRS: Numeric rating scale; PIS: Pain Interference Scale; HADS: Hospital and Anxiety Depression Scale; PWI-A: Personal Wellbeing Index – Adult version; PANAS: Positive and Negative Affect Schedule; SOPA: Survey of Pain Attitudes; PCS: Pain Catastrophizing Scale; SD: standard deviation.

Table 3. Pearson correlation between outcome variables, subjective well-being, and mediating variables ($n = 96$).

| | PI | PIF | D | LS | PA | NA | PC | PCAT |
|---|---|---|---|---|---|---|---|---|
| Outcome variables | | | | | | | | |
| Pain intensity (PI) | 1.000 | | | | | | | |
| Pain interference (PIF) | 0.512 | 1.000 | | | | | | |
| Depression (D) | 0.177 | 0.528 | 1.000 | | | | | |
| Subjective well-being | | | | | | | | |
| Life satisfaction (LS) | −0.066 | −0.442 | −0.704 | 1.000 | | | | |
| Positive affect (PA) | −0.187 | −0.441 | −0.665 | 0.635 | 1.000 | | | |
| Negative affect (NA) | 0.222 | 0.379 | 0.469 | −0.524 | −0.445 | 1.000 | | |
| Mediating variables | | | | | | | | |
| Pain control (PC) | −0.150 | −0.255 | −0.355 | 0.333 | 0.332 | −0.169 | 1.000 | |
| Pain catastrophizing (PCAT) | 0.308 | 0.488 | 0.531 | −0.508 | −0.380 | 0.536 | −0.407 | 1.000 |

*Note*: Sum scores of the respective measure were used to calculate correlations.



but no significant direct association of pain intensity with depression ($\beta = -0.01$; $-0.02$, $p = 0.833$; 0.866) and of pain interference with depression ($\beta = 0.10$, $p = 0.341$; 0.343). But both models showed significant indirect relationships of pain intensity with depression, mediated by pain interference ($\beta = 0.04$, $p < 0.001$).

The power to detect model misspecification in terms of RMSEA was low for both models, indicating a power for the test of close fit of 0.17.

## Discussion

The purpose of the present study was to better understand the relationship between subjective well-being and pain intensity, pain interference, and depression, and to examine if pain control and pain catastrophizing mediate the effects of subjective well-being on the outcome variables. This study showed that individuals who reported higher subjective well-being reported significantly lower interference of pain on activities and significantly less depressive symptoms. The findings also revealed that individuals who reported greater subjective well-being showed significantly lower pain intensity via the mediating effect of lower pain catastrophizing. However, since sample size and respective power are low, these findings should be taken as first indications of potential underlying mechanisms between subjective well-being and pain outcomes that need further confirmation.

Pain control was not a significant mediator of the associations of subjective well-being with pain intensity, pain interference, and depression. To the authors' knowledge, this is the first time that pain control has been examined as potential mediator in the association between well-being and adjustment to chronic pain. However, one study found that lower pain control was directly associated with higher pain intensity in individuals with chronic pain and SCI [7]. A possible reason for the negative finding of the current study is the specific study population; that is, the personal experience of pain and well-being might be different among individuals with no physical disability relative to individuals with a physical disability. Consistent with this idea, results from a large survey found that the experience of pain in individuals with a physical disability significantly differs from the experience in the normative US population [58]. Another possible reason for this negative finding, of course, is that pain control may simply not act as mediator in this specific model with this population.

Regarding subjective well-being, model 1 showed that individuals who reported greater subjective well-being showed significantly higher pain control. These findings are in line with results of a randomized controlled trial which showed that enhancing subjective well-being by practicing positive psychology exercises significantly increased pain control in individuals with chronic pain secondary to a physical disability [16].

Individuals who reported greater subjective well-being showed significantly lower pain intensity via the effect of lower pain catastrophizing. In addition, individuals who reported greater subjective well-being showed significantly lower pain interference through the effect of pain catastrophizing and pain intensity. Although research is limited regarding the mediating effect of pain catastrophizing in individuals with physical disabilities, one study found that pain catastrophizing is directly associated with pain intensity and pain interference in individuals with chronic pain secondary to MS or SCI [19]. This study also supports previous finding, which showed that changes in catastrophic thinking through cognitive behavioral treatment significantly reduced pain intensity in individuals with chronic low back pain [59].

Pain catastrophizing did not mediate the effect of subjective well-being on depressive symptoms, however. One possible reason for this negative finding is that there is no consensus in the current research concerning the association of pain catastrophizing and depression, as results examining this association have been inconsistent across studies. For example, pain catastrophizing and depression have been shown to be related (synergistically increasing pain when both were present) [60]. But, other studies argue that the reason for this close association may simply be an overlap in measurement construct (e.g., rumination can be assessed to measure depressive symptoms as well as catastrophic thinking) [61].

Regarding subjective well-being, model 2 showed that individuals who reported greater subjective well-being also reported significantly less pain catastrophizing. This is consistent with findings of the previous mentioned randomized controlled trial, which showed that practicing positive psychology exercises to increase subjective well-being lowered pain catastrophizing in individuals with chronic pain secondary to a physical disability [16].

With regards to the associations between the three outcome variables, both models showed that individuals who reported greater subjective well-being reported significantly less pain interference on activities and significantly less depressive symptoms. In addition, higher pain intensity was linked to higher pain interference and individuals who reported lower pain intensity showed lower depressive symptoms through the effect of less interference of pain on activities. These findings are consistent with the results of a study which found that happiness (i.e., meaning, pleasure, and engagement) was significantly associated with lower pain interference and distress through the effect of lower pain intensity in individuals with chronic pain and physical disabilities [16].

Finally, subjective well-being, happiness, and positive affect have been found to positively influence physiological [62,63] and psychological recovery [64] in response to stress, pain, or catastrophization [65]. It has been hypothesized that positive affect and high subjective well-being, respectively, might potentially determine trajectories of recovery for individuals living with chronic pain and it might be therefore a useful longitudinal mediator of psychological interventions [66], for example based on positive psychology.

### *Clinical implications*

The current findings can be used to identify the treatment targets that are more (or less) likely to most strongly influence outcomes. Specifically, the findings suggest that treatments which enhance subjective well-being (increasing positive affect and life satisfaction, and decreasing negative affect) and reducing pain catastrophizing may have the highest potential for benefiting individuals with disability-associated chronic pain. Cognitive behavioral therapy is a potential treatment approach to reduce pain catastrophizing by targeting irrational beliefs, maladaptive emotional responses, and dysfunctional behavioral patterns. Cognitive behavioral interventions were found to significantly reduce pain catastrophizing [59] depressive symptoms and enhance pain control [67] in individuals with chronic low back pain. Positive psychology interventions, which aim to develop and foster psychosocial strengths and resources, are a possible treatment approach for targeting and enhancing well-being. Consistent with this idea, there is evidence that positive psychology interventions can increase subjective well-being (life satisfaction and positive affect) and reduce depressive symptoms [68,69]. A recent study found that positive psychology exercises are significantly effective to increase positive affect, life satisfaction and pain control, and decrease pain catastrophizing, pain intensity, pain interference, and depressive symptoms in individuals with chronic pain secondary to a physical disability [16].

### *Limitation of the study*

This study has several limitations. First, our sample size was adequate but rather low for conducting SEM also in terms of power for model misspecification. Research with larger sample sizes would be useful to confirm the reliability of our findings. Second, this study included individuals with specific physical disabilities and results are based on a US community sample with a limited racial diversity (96% Caucasian) as well as mostly well-educated participants making generalizability of the findings difficult. In addition, there may be response bias in the sample, with individuals who are physically and psychologically healthier, being perhaps more likely to respond to study invitation letter and complete questionnaires. A third limitation is the cross-sectional design of the current study, which does not allow for causal conclusions regarding the associations among the study variables (the directions of arrows in SEM represents the researcher's hypotheses of causality within a system). Longitudinal research and true experiments (e.g., in which catastrophizing and/or well-being are systematically targeted for change) are needed to better understand the causal effect of subjective well-being on pain outcomes, and the mediating role of catastrophizing in these effects. Fourth, the study relied on self-reported measures, which may be linked to socially desirable responses and thus to measurement bias. As a fifth limitation, confounding factors that could potentially influence the associations among the variables in the models but not assessed in the current study need to be considered. For example, seeking medical help has been found to influence quality of life [70] and could potentially influence patient function or the mediation effects found here. In addition, type of pain (i.e., nociceptive, neuropathic) might be an additional potential confounding factor influencing the associations in the models. However, with almost a third of participants being classified as having (multiple) or unclear pain type multiple group analyzes to examine the potential confounding effects of type of pain in SEM was not possible. Finally, no information was available from individuals who did not respond to the initial approach letter. Therefore, a responder versus non-responder comparison to detect potential selection bias was not possible.

## Conclusion

The findings suggest that subjective well-being and pain catastrophizing may play key roles in efforts to reduce pain intensity, pain interference, and depressive symptoms in individuals with chronic pain and a physical disability. The findings have important implications for the treatment of chronic pain in individuals with a physical disability. Specifically, they suggest that positive psychology interventions may be useful for this population. Longitudinal research and clinical trials to evaluate the causal nature of well-being and catastrophizing – and the efficacy of treatments that target these variables – is warranted.

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## Disclosure statement

The authors report no conflict of interest.

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