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War experiences and relationship problems predict pain sensitivity cross-sectionally among patients with chronic primary pain

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ABSTRACT

Background: Most patients suffering from chronic pain are more susceptible to pain and pressure due to higher pain sensitivity. Since psychosocial factors play a central role in developing and maintaining chronic pain, investigating associations between pain sensitivity and psychosocial stressors promises to advance the bio-psychosocial understanding of chronic pain. Objectives: We aimed to replicate Studer et al.'s (2016) findings about associations of psychosocial stressors with pain sensitivity in a new sample of patients with chronic primary pain (ICD-11, MG30.0). Methods: A pain provocation test was used on both middle fingers and earlobes to assess pain sensitivity among 460 inpatients with chronic primary pain. *Potentially life-threatening accidents*, *war experiences*, *relationship problems*, *certified inability to work*, and *adverse childhood experiences* were assessed as potential psychosocial stressors. Structural equation modeling was used to investigate associations between psychosocial stressors and pain sensitivity. Results: We partially replicated Studer et al.'s findings. Similar to the original study, patients with chronic primary pain showed enhanced pain sensitivity values. Within the investigated group, *war experiences* ($\beta = 0.160$, $p < .001$) and *relationship problems* ($\beta = 0.096$, $p = .014$) were associated with higher pain sensitivity. In addition, the control variables of *age, sex,* and *pain intensity* also showed a predictive value for higher pain sensitivity. Unlike Studer et al., we could not identify a *certified inability to work* as a predictor of higher pain sensitivity. Conclusions: This study showed that beyond *age*, *sex*, and *pain intensity*, the psychosocial stressors of *war experiences* and *relationship problems* were associated with higher pain sensitivity.

1. Introduction

Patients suffering from chronic pain disorders often show increased sensitivity to pain and pressure stimuli (allodynia and hyperalgesia), caused by central sensitization [1]. Central sensitization is defined as an increased responsiveness of nociceptive neurons to normal and sub-threshold afferent input, due to a prolonged but reversible increase in excitability and synaptic efficacy of neurons in central nociceptive pathways, causing hypersensitivity and responsiveness to non-noxious stimuli [2–5]. It is assumed that repetitive or tonic nociceptive stimulation, as well as chronic negative emotions and distress, e.g., (childhood) trauma, neglect, and abuse, may be associated with hypothalamic-pituitary-adrenal (HPA) axis dysregulation and central sensitization [6–8]. As patients suffering from chronic pain disorders often show increased sensitivity to pain and pressure stimuli, assessing pain sensitivity serves as a central diagnostic characteristic in routine clinical assessment that supports treatment planning for patients with chronic pain [1].

As trauma seems to increase central sensitization [6], psychosocial factors such as childhood traumas play a crucial role in developing and maintaining chronic pain [9,10]. Similarly, patients suffering from chronic pain with a history of trauma seem to experience more severe

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symptoms and pain interference [6,11]. Although >50% of all post-traumatic stress disorder (PTSD) patients report pain as a leading symptom, and approximately 15% of all patients with chronic pain meet PTSD criteria, the relationship between PTSD and pain is poorly understood [12–15]. A recent meta-analysis showed inconsistent associations of different trauma experiences and pain thresholds among patients with PTSD, suggesting that the type of trauma may affect pain thresholds differentially [15], which may also apply to patients with chronic pain.

To our knowledge, the study by Studer et al. [16] was the first to systematically investigate associations of enhanced pain sensitivity with different past and current psychosocial stressors. Studer et al. [16] focused on patients with somatoform pain disorders (ICD-10, F45.41) and thereby compared the predictive value of the following stressors on pain sensitivity: *potentially life-threatening accidents*, *war experiences*, *adverse childhood experiences*, *relationship problems*, and a *certified inability to work*.

Studer et al. [16] found that *age*, *war experiences*, and a *certified inability to work* predicted higher pain sensitivity within the investigated group of chronic pain patients with somatoform pain disorders. The biological association between *older age* and higher pain sensitivity is in line with previous research, showing that older individuals seem more sensitive to mechanically evoked pain than younger individuals [17,18]. Although it has been shown that *traumatic experiences,* as well as *adverse childhood experiences* (ACE), seem to impact pain sensitivity [12,15,19], Studer et al. [16] were unable to show any other significant associations of enhanced pain sensitivity with other psychosocial stressors within their sample of pain patients with somatoform pain disorders.

To consolidate previous findings on the relationships between increased pain sensitivity and psychosocial stressors, we aimed to replicate Studer et al.'s [16] findings using a new and larger sample of inpatients with analog chronic pain disorders at the same site. Since the terminology has changed with ICD-11, inpatients with chronic primary pain were considered for this study. The identical psychosocial stressors were considered to investigate the association of enhanced pain sensitivity with stressors, i.e., *potentially life-threatening accidents*, *war experiences*, *relationship problems*, a *certified inability to work*, as well as *adverse childhood experiences*.

Since the category of chronic primary pain (ICD-11) subsumes many of the so-called central sensitivity pain disorders [20–22], we hypothesized a priori increased pain sensitivity values compared to reference values of a healthy norm or patients with chronic secondary pain. Based on the findings of Studer et al. [16] and previous findings showing higher levels of pain sensitivity for survivors of traumatic experiences with chronic pain [19], we assumed *war experiences* to be a risk factor for developing and maintaining a higher pain sensitivity. Moreover, we hypothesized, in line with the findings of Studer et al. [16], that *age* and a *certified inability to work* predict higher pain sensitivity in a sample of inpatients with chronic primary pain.

2. Methods

2.1. Sample

The sample consisted of 460 patients with chronic primary pain receiving inpatient care in the same tertiary psychosomatic university clinic in which Studer et al. [16] had recruited their sample. We included patients who fulfilled the criteria for chronic primary pain (MG30.0) according to the International Classification of Diseases (ICD-11) [23], were aged 18 or older with sufficient German-language proficiency, and provided written consent to the collection and further use of their data.

2.2. Ethics statement

The Ethics Committee of the Canton of Bern approved the study (project ID 2018–00493, ID 2021–02214), and we complied with the Declaration of Helsinki. All patients were informed about how their data will be used for research and provided their written consent to participate.

2.3. Procedures

All inpatients with chronic primary pain admitted between 2017 and 2021 completed an assessment at intake for the interdisciplinary pain treatment program. We assessed identical sociodemographic and clinical characteristics, potential psychosocial stressors, and pain sensitivity as Studer and colleagues [16].

2.4. Measures

2.4.1. Pain provocation test

A standardized pain provocation test, type peg algometry (Algopeg), was used to assess pain sensitivity at both middle fingers and earlobes. Peg algometry has been shown to be a non-inferior method of diagnosing allodynia and hyperalgesia and has been validated in clinical samples by comparing it to an electronic pressure algometer [1,24]. To apply mechanical pressure, standardized pegs of polypropylene and nickel (18 × 100 mm) set to a clamping force of 10 Newton at an extension of 5 mm were used. The test was conducted on both middle fingers and both earlobes of each patient. Sex- and age-adjusted percentile curves of healthy subjects exist to assess individual values [17]. Patients usually perceive pressure on the middle fingers as below or just at the pain threshold, indicating when pressure turns into a painful sensation [1,25]. At the earlobe, pressure is generally judged to be clearly above the pain threshold, measuring the ability to endure and tolerate pain [1,25]. The clamp was applied to the middle finger on the nail bed without touching the nail fold and to the earlobe in the central tissue without touching the ear cartilage. After 10 s (10s) of clamping, patients were asked to describe pain intensity on a numerical rating scale (NRS) ranging from 0 to 10 in 0.5 increments (0 = no pain,10 = worst pain imaginable). If patients could not endure the duration of 10s, the test was noted as prematurely terminated and rated "10".

2.4.2. Interview to assess psychosocial stressors

Clinicians (physicians or psychologists) assessed psychosocial stressors during a semi-structured interview at intake. The assessed psychosocial stressors were potentially *life-threatening accidents*, direct or indirect (e.g., family members) *war experiences*, *relationship problems* (e.g., domestic violence or abuse), a *certified inability to work*, and *adverse childhood experiences*. They were rated as a "1″ if patients reported these stressors or a "0″ if they did not.

2.4.3. Questionnaire to assess adverse childhood experiences

For assessing *adverse childhood experiences*, clinicians also used the German version of the Adverse Childhood Experiences (ACE—D) questionnaire at intake [26], which contains ten items regarding abuse, neglect, and other adverse experiences before the 18th birthday. The individual ACEs were rated either as a "1″ if patients reported these stressors or a "0″ if they did not. The single ACEs can be summarized in a total score.

2.4.4. Assessing an illness-related inability to work

In Switzerland, physicians can certify a partial or complete *inability to work* by indicating the percentage to which patients are currently unable to carry out the work that was required in their previous employment due to pain conditions or risks of those conditions deteriorating further. Therefore, a five point-Likert scale was used to assess illness-related inability to work, ranging from 0 = no inability to work (0%) to 4 = complete inability to work (100%, where each level corresponds to a 25% difference in the inability to work).

2.4.5. Sociodemographic and clinical characteristics

Age, sex, citizenship, marital status, pain duration, and average pain intensity were measured as sociodemographic and clinical characteristics.

2.5. Statistical analyses

We used IBM SPSS Statistics (version 27) and RStudio (version 2021.09.2 + 382) to analyze the data [27,28]. First, we performed descriptive analyses for sociodemographic and clinical characteristics, i.e., pain sensitivity and psychosocial stressors. Spearman correlations were used to investigate the relationship of peg algometry values with psychosocial stressors, age, sex, pain intensity, and pain duration. We set the significance level at $\alpha = 0.05$ (two-tailed).

Structural equation modeling was used to investigate the relationship between pain sensitivity and psychosocial stressors. Due to a likely high correlation of the peg algometry scores of the middle fingers and earlobes, we assumed that they both measure a shared latent construct. Therefore, the model consisted of pain sensitivity as a latent (endogenous) variable, combining the manifest indicators of pain sensitivity measured on both fingers and earlobes. The model's manifest (endogenous) psychosocial stressors were *life-threatening accidents*, *relationship problems*, a *certified inability to work*, and *war experiences*. *Adverse childhood experiences* as a latent variable combined the 10 manifest variables regarding abuse, neglect, and other adverse experiences before the 18th birthday. *Age* and *sex* were included as control variables since older individuals and females tend to have higher pain sensitivity scores than younger individuals and males [29,30]. Moreover, pain intensity and pain duration were included as control variables, due to the significant correlations with peg algometry values. While Studer et al. [16] used the maximum likelihood estimation method for their analyses, we decided to use the diagonally weighted least squares estimation method to account for the categorical variables in the model.

Regarding structural equation structures, the literature recommends a minimum sample size of 100 individuals, although samples of $N \geq 200$ are more appropriate [31–33]. Other recommendations relate the sample size to the complexity of the model and therefore recommend a sample size derived from the eq. 5 * t, where t represents the number of parameters to be estimated [31]. Since 63 parameters are estimated for the present structural equation models, a sample size of 315 individuals would be desirable, so the current study's sample size can be regarded as sufficient.

The model quality was interpreted based on different quality criteria by Moosbrugger and Kelava [34]. The χ^2 test, the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR) were used to interpret the model fit. We considered an acceptable model fit for values for RMSEA less than or equal to 0.08 and SRMR less than or equal to 0.10 [34]. Model fits with an RMSEA or SRMR less than or equal to 0.05 were described as good [34].

3. Results

3.1. Sociodemographic and clinical characteristics

We summarized sociodemographic and clinical characteristics in Table 1. On average, patients were 48 years old. The sample mainly consisted of female patients who were married or in a permanent relationship. The majority of patients were either native or naturalized Swiss. Over 40 % of all patients had suffered from a pain period for 1–5 years, and about one-third for more than ten years. Furthermore, patients indicated an average pain intensity of 5.5 ($SD = 1.7$) on an NRS of 0–10. Table 2 summarizes descriptive statistics of psychosocial stressors. More than two-thirds of the patients reported a partial or complete pain-related, medically *certified inability to work*. Comparable to the sample of Studer et al. [16], patients reported, on average, 1–2 *adverse childhood experiences* ($M = 1.60$, $SD = 2.06$). 37.8% of all inpatients reported more than one adverse childhood experience. 12–14% of all inpatients reported potentially *life-threatening accidents*, *war experiences* and/or *relationship problems*.

Table 1
Sociodemographic and clinical characteristics.

			Range
Age – M (SD)	47.5	(12.9)	18–81
Sex – N (%)			
female	285	(62.0)	
male	175	(38.0)	
Citizenship – N (%)			
Native Swiss	273	(59.3)	
Naturalized Swiss	73	(15.9)	
Other nationality	114	(24.8)	
Marital status – N (%)			
In a relationship	44	(9.6)	
Married	224	(48.7)	
Divorced / separated	97	(21.1)	
Widowed	15	(3.3)	
Single	80	(17.3)	
Pain duration – N (%)			
0–3 months	7	(1.5)	
4–6 months	20	(4.3)	
7–11 months	18	(3.9)	
1–5 years	194	(42.2)	
6–10 years	70	(15.2)	
>10 years	151	(32.8)	
Pain intensity – M (SD)	5.5	(1.7)	

Notes: $N = 460$. Due to the absence of war in Switzerland, native and naturalized Swiss were differentiated. The category 0–3 months only included patients with pain lasting at least three but less than four months.
Abbreviations: M = mean; SD = standard deviation; N = number of patients.

Table 2
Descriptive statistics of psychosocial stressors.

Psychosocial stressors– N (%)		
Inability to work		
0%	164	(35.7)
≤ 25%	5	(1.1)
≤ 50%	25	(5.4)
≤75%	22	(4.8)
≤100%	244	(53.0)
Adverse childhood experiences		
Emotional abuse	62	(13.5)
Physical abuse	120	(26.1)
Sexual abuse	85	(18.5)
Domestic violence	92	(20.0)
Household with substance abuse	25	(5.4)
Parent with mental health condition	51	(11.1)
Member of household incarcerated	75	(16.3)
Emotional neglect	4	(0.9)
Physical neglect	169	(36.7)
Parental abandonment through separation or divorce	53	(11.5)
Potentially life-threatening accidents	57	(12.4)
War experiences	65	(14.1)
Relationship problems	64	(13.9)

Notes: N = 460.
Abbreviations: N = number of patients.

3.2. Pain sensitivity

Table 3 shows descriptive statistics of pain sensitivity of inpatients with chronic primary pain and its comparison with Studer et al.`s sample [16], a sample of healthy participants [17], and a sample of patients with nociceptive (chronic secondary) pain [25]. Studer et al.`s sample [16] consisted of 166 patients with somatoform pain disorders. Patients were on average 46 years old, and 55.4% of them were female [16]. The mean age of the healthy norm sample was 51 years, and consisted of 648 pain-free participants; 53.5% were female [17]. The sample of 53

Table 3
Descriptive statistics of pain sensitivity and comparison with samples of a healthy norm and samples of chronic secondary pain on a numerical rating scale (NRS) ranging from 0 to 10 (0 = no pain,10 = worst pain imaginable).

		Pain Sensitivity		
	N	M	SD	Median
Inpatients with chronic primary pain	460			
Peg algometry right middle finger		3.2	(2.9)	2.5
Peg algometry left middle finger		3.3	(2.8)	3.0
Peg algometry right earlobe		7.3	(2.9)	8.0
Peg algometry left earlobe		7.2	(3.0)	8.0
Inpatients with somatoform pain [16]	166			
Peg algometry middle finger		3.1	(2.5)	
Peg algometry earlobe		7.0	(2.6)	
Healthy norm [17]	648			
Peg algometry middle finger				1.0–1.5
Peg algometry earlobe				5.5–6.0
Patients with nociceptive pain [25]	53			
Peg algometry middle finger		1.7	1.0	
Peg algometry earlobe		4.2	1.6	

Abbreviations: M = mean; SD = standard deviation, N = number of patients.

patients with nociceptive pain (chronic secondary pain) showed a mean age of 55 years and consisted of 32.1% females [25]. The average pain sensitivity on both middle fingers and earlobes was similar to the values of Studer et al. [16]. Similar to the original study, patients with chronic primary pain showed clearly heightened pain sensitivity values compared to samples with healthy participants and patients with nociceptive pain [17,25].

3.3. Correlation analysis and sex differences

We calculated Spearman correlations (Table 4) to investigate the associations between psychosocial stressors and pain sensitivity. Only *war experiences* correlated significantly ($r(458) = 0.17$, $p < .001$) with both peg algometry scores measured at the earlobes. None of the other psychosocial stressors correlated significantly with the peg algometry scores measured at the middle fingers and the earlobes. *Age* correlated significantly with the peg algometry scores for the middle fingers (right: $r(458) = 0.16$, $p < .001$; left: $r(458) = 0.14$, $p = .002$) and left earlobe ($r(458) = 0.11$, $p = .024$). Similarly, *sex* correlated significantly with the peg algometry scores for the middle fingers ($r(458) = -0.18$, $p < .001$) and left earlobe ($r(458) = -0.11$, $p = .021$). Average pain intensity correlated significantly with both peg algometry scores for middle fingers (right: $r(458) = 0.26$, $p < .001$; left: $r(458) = 0.24$, $p < .001$) and earlobes (right: $r(458) = 0.29$, $p < .001$; left: $r(458) = 0.32$, $p < .001$). Pain duration correlated only significantly with peg algometry scores for earlobes (right: $r(458) = 0.11$, $p = .021$; left: $r(458) = 0.11$, $p = .025$). This indicates that older and female patients, as well as patients with higher pain intensity and longer pain duration show higher pain sensitivity.

Table 4
Spearman correlations of study variables.

	Peg algometry right middle finger	Peg algometry left middle finger	Peg algometry right earlobe	Peg algometry left earlobe
Peg Algometry right middle finger	–			
Peg Algometry left middle finger	0.827***	–		
Peg Algometry right earlobe	0.529***	0.466***	–	
Peg Algometry left earlobe	0.503***	0.541***	0.804***	–
Adverse childhood experiences sum score	−0.037	0.007	−0.043	0.002
Potentially life-threatening accidents	0.021	−0.045	0.046	−0.001
War experiences	0.090	0.057	0.166***	0.168***
Relationship problems	0.068	0.062	0.083	0.086
Inability to work	0.011	−0.010	−0.021	−0.041
Age	0.158***	0.142**	0.073	0.106*
Sex	−0.179***	−0.178***	−0.087	−0.108*
Average pain intensity	0.260***	0.236***	0.294***	0.319***
Pain duration	0.058	0.076	0.107*	0.105*

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.

Sex differences regarding pain sensitivity are summarized in Table 5. Females had significantly higher pain sensitivity scores in the left and right middle fingers as well as in the left earlobe than males. Therefore, we included age, sex, pain intensity, and pain duration as control variables in the structural equation model.

3.4. Prediction of pain sensitivity by psychosocial stressors

We summarize the model predictions of pain sensitivity by psychosocial stressors in Fig. 1. The fit of the defined model can be considered as acceptable to good, with $\chi^2(190) = 294.1$ ($p < .001$), RMSEA = 0.035, and SRMR = 0.053. The control variable of *age* with 0.138 ($SE = 0.01$, $p = .001$) was a significant predictor of higher pain sensitivity. Furthermore, the control variable (female) *sex* predicted higher pain sensitivity significantly with −0.186 ($SE = 0.17$, $p < .001$). Moreover, the control variable *pain intensity* was the strongest predictor of higher pain sensitivity with 0.364 (SE = 0.06, p < .001). *War experiences* 0.160 ($SE = 0.23$, $p < .001$) and *relationship problems* 0.096 ($SE = 0.23$, $p = .014$) were the only psychosocial stressors predicting higher pain sensitivity within the investigated group of patients with chronic primary pain. *Pain duration* ($p = .138$), *potentially life-threatening accidents* ($p = .873$), an *inability to work* ($p = .817$), and *adverse childhood experiences* ($p = .535$) were not significantly associated with pain sensitivity among this sample of patients with chronic primary pain.

4. Discussion

We aimed to replicate the findings of Studer et al. [16] regarding the association between enhanced pain sensitivity and various psychosocial stressors among patients with chronic primary pain.

Analogous to the patient population studied by Studer et al. [16], our sample of patients with chronic primary pain is a priori characterized by increased pain sensitivity at all examined body sites compared to healthy individuals and patients with nociceptive pain [17,25]. The algometry values of patients with chronic primary pain were very similar to those in the original study and other patient samples with somatoform pain [1,16,25], which underlines the robustness of the

Table 5
Number of patients, mean, standard deviation, and effect size of sex differences.

	Females $N = 285$		Males $N = 175$			
	M	*SD*	*M*	*SD*	*t*	*d*
Peg algometry right middle finger	3.60	2.96	2.58	2.59	3.78***	0.363
Peg algometry left middle finger	3.70	2.90	2.67	2.52	3.88***	0.373
Peg algometry right earlobe	7.48	2.84	7.01	2.94	1.73	0.166
Peg algometry left earlobe	7.41	2.88	6.74	3.07	2.34***	0.225

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: N = number of patients; *M* = mean; *SD* = standard deviation; *t* = *t* value; d = Cohen's *d*.

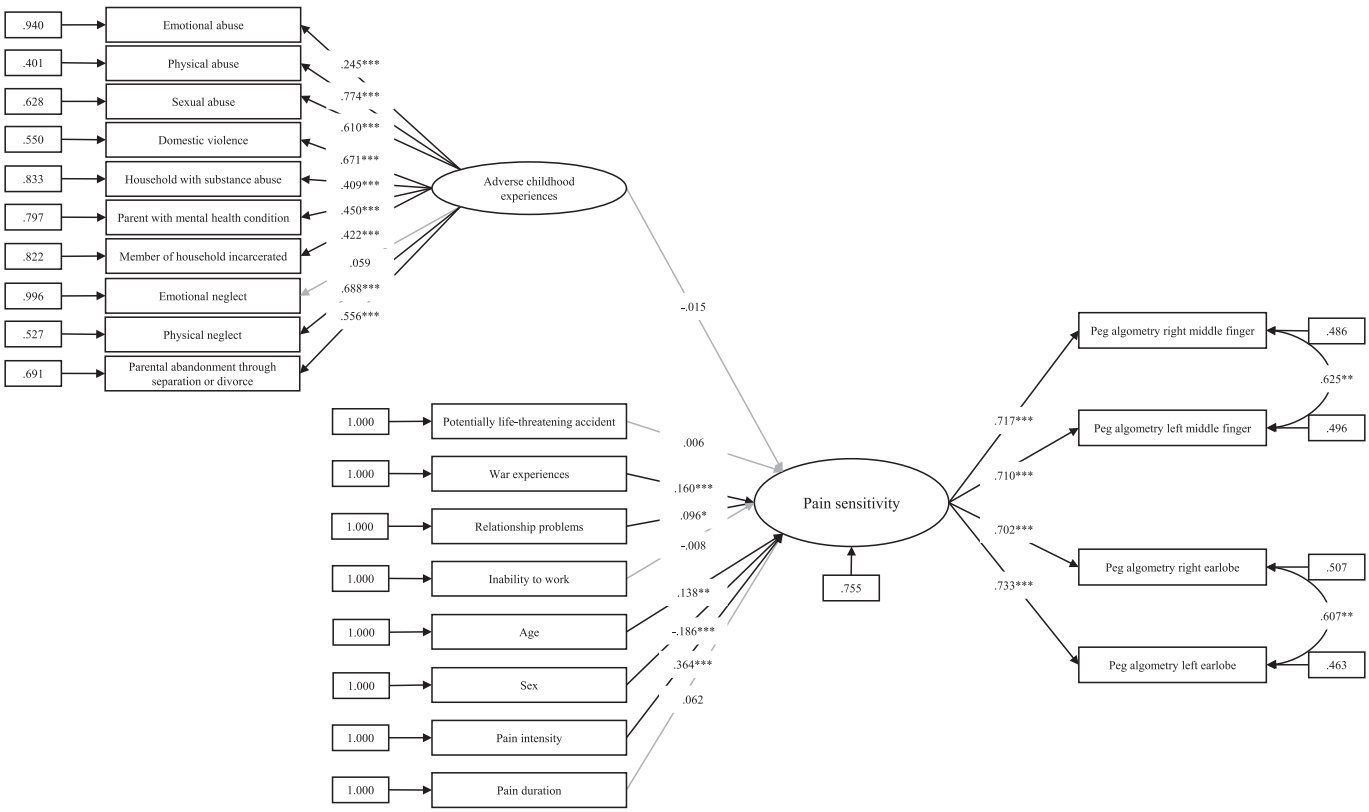

Fig. 1. Model predictions of pain sensitivity by psychosocial stressors.
Notes: Illustration of the structural equation model with standardized effects (β) of the manifest and latent independent variables (left) and manifest indicators of pain sensitivity (right). Black arrows indicate statistically significant effects (* $p < .05$, ** $p < .01$, *** $p < .001$). Model fit: $\chi^2(190) = 294.1$ ($p < .001$), RMSEA = 0.035, SRMR = 0.053.

hypersensitivity data. This result shows once again that hypersensitivity is a key mechanism that explains how pain disorders without explicable tissue damage can be understood [22].

Correlation analyses showed significant associations of higher pain sensitivity with older age, female sex, higher pain intensity, and longer pain duration, which aligns with previous research [35–37]. Interestingly, *potentially life-threatening accidents, relationship problems, inability to work*, and *adverse childhood experiences* did not correlate significantly with pain sensitivity. *War experiences* was the only psychosocial stressor that correlated significantly with pain sensitivity (when measured on the earlobes), although the correlation was small. Studer et al. [16] reported similar correlations in a similar sample of patients with somatoform pain. Lower variance due to the homogeneity of the sample and assessment of most psychosocial stressors as dichotomous variables might explain small and non-significant correlations in the current study.

Regarding the predictive value of specific stressors for increased pain sensitivity, structural equation modeling confirmed that the psychosocial stressors of *war experiences* and *relationship problems* were cross-sectionally associated with higher pain sensitivity above and beyond the control variables of *age, sex and pain intensity*. Therefore, Studer et al.'s [16] findings could be partially replicated.

Studer and colleagues [16] had found that a *certified inability to work* predicted higher pain sensitivity, which we could not replicate in our sample. In the current sample, the majority of patients with chronic primary pain were "completely" unable to work (100%), whereas most patients in the study by Studer et al. [16] were able to work part-time. Given that in our sample, an *inability to work* often coincided with the duration of pain, it can likely be considered both, a psychosocial stressor, as well as a consequence of suffering from chronic pain.

Like Studer et al. [16], neither *life-threatening accidents* nor *adverse childhood experiences* predicted higher pain sensitivity among patients with chronic primary pain. Whereas previous research has shown that traumatic experiences as well as adverse childhood experiences (ACE) seemed to impact pain sensitivity [12,19], it is important to note that non-significant associations between pain sensitivity and other psychosocial stressors in our sample do not mean that these stressors are irrelevant for the experience of pain in general. It rather suggests that those psychosocial stressors do not explain *increased* pain sensitivity among patients with chronic primary pain.

However, in the cross-sectional comparison of a generally increased pain perception (of chronic primary pain), the psychosocial stressors *war experiences* and *relationship problems* seemed particularly noteworthy. The current reality of war in Eastern Europe testifies to immeasurable misery, so it is intuitively understandable that this enormous stressor influences everything, including individual pain perception. Similarly, the assessed relationship problems might also encompass domestic abuse in the sense of controlling, coercive, threatening behavior, violence, or abuse in a relationship, likely causing tremendous distress and suffering [8,38]. In support of this reasoning, both *war experiences* and *relationship problems* in the sense of domestic abuse and violence have been shown to lead to a severe dysregulation of the HPA axis, being also evident in PTSD and being associated with higher pain sensitivity [15,39].

In sum, these reported findings underscore the importance of assessing potential psychosocial stressors, traumas, and related symptoms, such as the ones associated with *war experiences* and *relationship problems,* when treating patients with chronic primary pain. Furthermore, since both *war experiences* and *relationship problems* might put individuals at risk for developing PTSD and might increase central sensitization, it is vital to identify PTSD symptoms as early as possible to treat patients with chronic pain more effectively.

5. Strengths, limitations and future research

Besides partially replicating Studer et al.'s [16] findings with a new and larger sample from the same site, several limitations need to be addressed. As consent was required to analyze the data of inpatients with chronic primary pain, this study may not be representative of all inpatients and chronic pain patients in general. Future studies might benefit from further differentiating between the various primary chronic pain diagnoses. Moreover, memory bias or general response effects may have contributed to the self-report of psychosocial stressors [40]. Similarly, it is unclear whether reported abuse or neglect (e.g., physical) goes along with other adverse childhood experiences (e.g., emotional abuse or neglect), possibly leading to inconsistent data concerning the ACE.

Furthermore, expectancy effects may have influenced the semi-quantitative, subjective assessment of pain sensitivity. In such cases, a lowered pain threshold may not necessarily result from a peripherally lowered pain threshold but could also be explained by negative expectations (e.g., a nocebo effect) [41]. Future longitudinal studies are needed to further examine potential causal relationships between psychosocial stressors and pain sensitivity. Moreover, it would be interesting if the other psychosocial stressors would become significant in samples, including patients with chronic secondary pain, which would increase the variance in pain sensitivity. Because relationship problems have been newly identified as an additional psychosocial stressor predicting pain sensitivity, replication is needed to substantiate the results of this work.

6. Conclusions

Our study confirms that patients with chronic primary pain are characterized by increased pain sensitivity. Furthermore, we found that, beyond the aspects of *age, sex*, and *pain intensity*, the psychosocial stressors of *war experiences* and *relationship problems* cross-sectionally predicted increased pain sensitivity, highlighting the importance of identifying and treating potential traumas among patients with primary chronic pain.

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Ethics approval (include appropriate approvals or waivers)

This research has been approved by the ethics committee of the Canton of Bern, Switzerland (project ID 2018–00493, ID 2021–02214) and is in accordance with the Declaration of Helsinki.

Consent to participate (include appropriate consent statements)

All patients were informed about the use of their data for research purposes and provided informed general consent.

Consent for publication

Patients signed informed consent regarding publishing their data.

Authorship

Authorship has been granted only to those individuals who have contributed substantially to the research and manuscript.

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Declaration of Competing Interest

None.

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