Chronic pain and comorbid posttraumatic stress disorder

Potential mechanisms, conceptualizations, and interventions

Andersen, Tonny Elmose; Ravn, Sophie Lykkegaard

Published in:
Current Opinion in Psychology

DOI:
10.1016/j.copsyc.2025.101990

Publication date:
2025

Document version:
Final published version

Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Psychology

Review

Chronic pain and comorbid posttraumatic stress disorder: Potential mechanisms, conceptualizations, and interventions

Tonny Elmose Andersen[1] and Sophie Lykkegaard Ravn[1,2]

Posttraumatic stress disorder (PTSD) is a common comorbidity to chronic pain, among others due to potentially shared posttraumatic origin. There has been growing interest in this field in the past decades, also providing some important studies to support our understanding of this comorbidity and how to address it in clinical practice. However, there are still important questions, particularly regarding the potentially shared vulnerabilities, mutually maintaining mechanisms, and how to best treat this comorbidity. This article provides a brief and up-to-date review of what we argue to be some of the most important studies within the field of chronic pain and comorbid PTSD and will discuss some of the current challenges and ways forward.

Addresses
[1] Department of Psychology, University of Southern Denmark, Odense, Denmark
[2] Specialized Hospital for Polio and Accident Victims, Rødovre, Denmark

Corresponding author: Andersen, Tonny Elmose (tandersen@health.sdu.dk)

Chronic pain and PTSD frequently co-occur. In clinical pain populations, self-reported PTSD prevalence rates are as high as 20.4 % [1]. Similarly, veterans of war very frequently report pain symptoms [2,3]. In 5,846,453 service users of the United States' National Veterans Affairs, 35.8 % met criteria for chronic pain, of which 21.6 % also fulfilled criteria for PTSD, leaving a total of 7.7 % of the full sample who suffer from both conditions [3]. This subgroup also had increased odds of additional comorbidity compared to either condition alone, among others including increased levels of sleep disorder, depressive disorder, and opioid use disorder [3]. This is in line with other studies finding increased pain, disability, and distress in people with the chronic pain and comorbid PTSD symptoms compared to people with chronic pain only [4–6], underlining a potential greater complexity in people suffering from both conditions.

The frequency of the comorbidity between PTSD and chronic pain has led to multiple attempts to illuminate this interrelationship. It has been argued that the two conditions share biological and psychological vulnerability factors such as a lowered physiological alarm threshold and anxiety sensitivity increasing the risk for developing both conditions in parallel [7]. Further, it has been argued that the two conditions not only coexist, but instead mutually maintain each other [8]. The Mutual Maintenance Model hypothesize that the conditions are maintained or exacerbated through several dysfunctional cognitive, behavioral, and affective mechanisms such as attentional biases, cognitive and behavioral avoidance, anxiety sensitivity, and extensive cognitive demands limiting coping capacities [8]. This is in line with the Perpetual Avoidance Model [9], suggesting that PTSD intrusion symptoms lead to hyperarousal, then feeding into a circle of pain, catastrophizing, and avoidance behavior, further maintaining and exacerbating PTSD intrusion. Furthermore, shared neuroanatomy and neurobiology of this comorbidity has also been discussed, providing an additional perspective on potential contributors for coexistence and interaction [10].

Arguably, the perspective of mutual interaction and maintenance has gained the most attention in the field. The evidence of mutual maintenance is mixed with some studies finding evidence of mutual interaction patterns and others unidirectional interaction patterns over time [11], probably due to different assessment methods, populations, and traumatic events studied. In minor injuries where pain and PTSD are due to same event, early PTSD hyperarousal has been found to be both unidirectionally [12] and bidirectionally [13] associated with pain over time in studies using cross-lagged analysis. Hence, this evidence does not suggest that PTSD intrusion plays a crucial role in this population, as otherwise envisioned by the Perpetual Avoidance Model [9]. However, this link has been established in burn victims where intrusion has been found as the primary

Current Opinion in Psychology 2025, **62**:101990

This review comes from a themed issue on Pain (2025)

Edited by Lance McCracken and Kevin Vowles

For complete overview about the section, refer Generation COVID: Coming of Age Amid the Pandemic (2024)

Available online 4 January 2025

https://doi.org/10.1016/j.copsyc.2025.101990

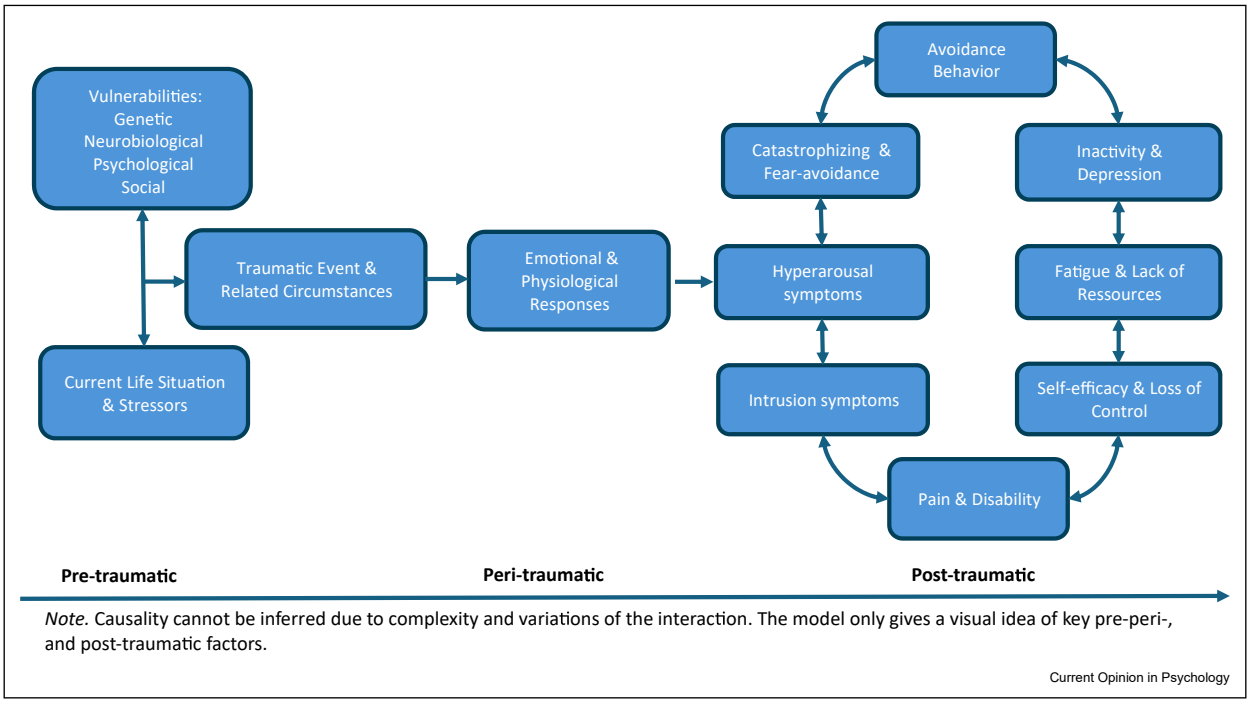
driver of pain over time [14]. This may be explained by painful burns being an integrated part of the trauma itself why pain becomes a natural trigger of intrusive thoughts. Similarly, pain associated with interpersonal trauma has been found to be an interwoven part of the traumatic event. For instance, individuals who have been subjected to severe torture described their pain symptoms in ways that resonated with the experience of interpersonal violence using words like terrifying, penetrating or killing, which was not seen in controls with chronic pain [15]. Finally, the following quote illustrates how living with the two conditions may be experienced differently by the individuals in question: "They [the conditions] don't affect one another; they affect *me*. So, I have to fight one side, and then the resources of course disappear from the other" [16], p. 1685]. For these reasons, a single conceptual model may be insufficient to explain the interaction between pain and PTSD in all cases. Nevertheless, the Conceptual Model of Co-Developmental and Mutual Maintenance of Chronic Pain and PTSD (See Figure 1.) is our attempt to provide a conceptual overview of some of the key factors and potential mechanisms involved in this coexistence of chronic pain and PTSD [17].

Assessment and conceptualizations of PTSD

In the discussion of PTSD in the context of chronic pain, there are several important methodological elements to take into consideration.

First, we argue it is important to notice that PTSD is conceptualized differently by the two current diagnostic systems applied worldwide, namely the Diagnostic and Statistical Manual of Mental Disorders, fifth edition Text Revision [18] (which holds no changes to PTSD compared to DSM-5) and the International Classification of Diseases, 11th edition [19]. DSM-5 (-TR) captures a broad conceptualization of PTSD comprised by 20 symptoms belonging to four symptoms clusters: Intrusion, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity [18]. With these 20 symptoms, DMS-5 (-TR) includes several so-called non-specific PTSD symptoms (e.g., concentration difficulties and sleeping difficulties), which respondents with chronic pain will likely recognize, also without having PTSD symptoms. On the other hand, ICD-11 captures a narrower conceptualization comprising only six symptoms belonging to three symptoms clusters: Re-experiencing, avoidance of traumatic reminders, and hypervigilance or enhanced startle reaction [19]. These are often regarded as the core symptoms of PTSD. For the general debate about the different conceptualizations of PTSD in the current diagnostic systems, many interesting papers are published [e.g. Refs. [20–22]]. As a further note, it is also important to notice that much of the research applies earlier versions of these two diagnostic systems, which also have differences in conceptualizations. As of relevance to the chronic pain field specifically, although similar prevalence rates of PTSD are captured by the

Figure 1



Conceptual Mode of the Co-Development and Mutual Maintenance of Chronic Pain and PTSD Symptoms.

two diagnostic systems in chronic pain samples, different individuals are identified, as indicated by modest diagnostic agreement between the two diagnostic systems (k = 0.60−0.64) [23,24]. This may not be problematic since the two symptoms captures different phenotypes of PTSD. However, it may impact the conclusions drawn from outcome studies assessing the potential impact of comorbid PTSD in the context of pain rehabilitation. Indeed, comparing the impact of PTSD symptoms identified by the two systems, Andersen et al. [23] found that only patients identified by the ICD-11 and not DSM-5 had poorer outcomes after pain rehabilitation. This may reflect higher symptom overlap with pain-related distress as captured by the DSM-5. Also, complex PTSD symptomatology with dissociative symptoms and disturbances in self-organization may be differently associated with pain compared to PTSD without such symptoms. This is indicated in a meta-analysis assessing the associations of PTSD and pain sensitization, where combat-related PTSD was found to be associated with decreased pain sensitivity while accident-related PTSD was associated with increased sensitivity to pain [25]. This decreased sensitivity to pain may be related to dissociation, which is much more prevalent in combat- and torture-related PTSD and rarely seen in accident-related PTSD such as whiplash injuries [26]. Hence, different *phenotypes* of PTSD may be associated with the nature of the traumatic event. This is important since shared vulnerabilities and pain sensitization mechanisms seem to be associated with trauma type. Interpersonal traumas have the highest risk in relation to the development of PTSD and burden of symptoms, whereas non-intentional traumas such motor vehicle crashes have a lower risk and symptom burden [27]. In addition, a recent meta-analysis of 57 studies found that adverse childhood experiences are significantly associated with chronic pain and pain related disability as an adult with an increased risk from one adverse childhood experience (OR 1.29) to four or more adverse events (OR 1.95) [28]. Early traumatic experiences may lead to epigenetic changes causing dysregulation is the stress response-system [29]. Indeed, Feinberg et al. [13] found that individuals with one or more copies of the FKBP5 stress gene are vulnerable for developing PTSD hyperarousal after motor vehicle crash (MVC). Moreover, among this vulnerable group PTSD hyperarousal mediated the relationship between acute pain and pain six months post-crash [13]. As such, not only the diagnostic system applied in studies can be of importance for the findings, but also the nature of the traumatic event.

Further, it is also important to take into consideration that - in addition to PTSD conceptualization, nature of traumatic event, and assessment tools - there are large differences in whether we speak of PTSD symptoms or PTSD as a disorder. In research, the two are often used synonymously, but there are important implications for the conclusions that can be made. As such, all these methodological factors are important to take into consideration in reading the literature.

Treatment of chronic pain with co-morbid PTSD symptomatology

A recent systematic review of the effect of psychological and multimodal treatments of PTSD and pain concluded that psychological interventions have small to moderate effects on PTSD symptoms only [30]. These results should be interpreted with caution due to the different nature of the interventions and the populations studied. Also, there was no requirement of meeting full criteria for comorbid diagnosis of chronic pain and PTSD for the studies included in this review. Taking a closer look at recent randomized controlled studies applying stricter criteria of comorbidity of chronic pain and PTSD according to predefined diagnostic criteria or cut-off scores, it is evident that not many large-scale randomized controlled trials (RCT) have been conducted [31−34], while some additional pilot and feasibility studies exist [35−39]. Below, we will briefly describe some of the main findings within these.

Following the pilot study by Dunn et al. [37], Andersen et al. [33] assessed the effect of 10 weeks adapted prolonged exposure (PE) therapy followed by a 6-week physiotherapy exercise program compared to 10 weeks supportive therapy (ST) also followed by the same exercise program. Although PE improved PTSD intrusion and avoidance at 12-month follow-up to a greater degree than ST, no differences were found between the two interventions in pain related disability or pain intensity. The results are in line with results from a small group CBT program (n = 33) integrating elements from PE to group CBT for chronic pain with co-morbid PTSD [35] and a recent single-case experimental study adding PE to multidisciplinary pain rehabilitation [40], also primarily finding change in PTSD symptoms with few reductions in pain intensity and interference. Of these studies, only Dunn et al. [37] and Andersen et al. [33] addressed patients with chronic pain and PTSD due to the same traumatic event.

Andersen et al. [31,32] assessed the effect of the body-oriented intervention Somatic Experiencing (SE) [41] in patients with chronic low back pain and PTSD, where the conditions did not necessarily develop due to the same traumatic event. SE aims to treat PTSD symptoms in a bottom-up approach by directing the patient's attention to internal sensations and thereby combining arousal reduction strategies with mild exposure to the traumatic experience. Hence, SE offers an alternative approach compared to CBT that is more oriented towards cognitions and direct exposure. Both trials assessed the effects of SE plus guided exercises

compared to guided exercises alone. Andersen et al. [31] showed results in reducing PTSD symptoms and fear of movement, but no effects on pain and disability. For this reason, Andersen et al. [32] added more sessions of SE and a manualized physiotherapeutic program focusing on fear of movement and exposure, resulting in no group differences in neither disability, pain, nor PTSD.

Finally, two large RCTs have been conducted in veterans of war [34,42]. Haun et al. [34] found no effect on pain nor PTSD of a self-care app for veterans and their partners compared to a wait-list group based on didactic self-care instructions such as psychoeducation, massage, meditation, and positive psychology. Burgess et al. [42] was a large three-armed pragmatic RCT for chronic pain among veterans, assessing the effect of an 8-weeks telehealth mindfulness-based group intervention either self-paced or guided compared to usual care. Although no formal diagnosis of PTSD was required for inclusion, the participants had high levels of comorbid PTSD symptoms, which is why we decided to include the study in this paper. Both mindfulness groups reported significantly lower pain interference, pain, and PTSD symptoms at all follow-ups (10 weeks, 6, and 12-months) compared to controls [39]. Further, Otis et al. [39] recently published a description of a brief, intensive, and integrated treatment program and a pilot testing among 8 veterans of war, where they found significant reductions in PTSD symptoms, pain, and pain catastrophizing, but not in pain interference, although symptom reductions were identified. As such, this would be of interest to explore further.

Recently, promising results have been demonstrated in two trials addressing subacute and acute whiplash associated disorders with early elevated levels of PTSD arousal symptoms [43,44]. Sterling et al. [43] compared physiotherapist-delivered stress inoculation training (SIT), among others addressing coping strategies to manage (sub)acute stress and triggers, integrated with guideline-based exercise to guideline-based exercise alone. SIT was more effective than exercises alone in reducing pain related disability and PTSD symptoms [43]. Nikles et al. [44] targeted early central sensitization of pain after whiplash injury (<48 h) pharmacologically with pregabalin. Although the study was only a pilot study (n = 24), a rigorous double-blinded placebo-controlled design was applied, and large effect sizes on both pain intensity and PTSD symptoms were found [44]. As such, it will be interesting to follow this line of research.

In conclusion, the existing evidence makes it difficult to come up with strong recommendations that can guide clinical practice, underlining a need for future high-quality studies. Further, the only modest knowledge on how to treat this comorbidity may also partly be explained by the lack of targeting of the right mechanisms driving this comorbidity. Also, heterogenous populations and chronicity of pain and PTSD may explain the modest effects. Mutual maintenance of pain and PTSD may primarily be seen in cases where the two conditions are due to the same traumatic event.

Reflecting and discussing points

Due to the lack of large RCTs targeting chronic pain and PTSD it is still not evident how to best treat this comorbidity. It is not known whether both conditions need to be targeted sequentially, in parallel, or by an integrated intervention. Evidence points in the direction of integrating cognitive behavior therapy techniques in the treatment of comorbid PTSD and pain. However, one size may not fit all. It is important to take the nature of the traumatic event into consideration, since the interaction of pain and PTSD symptomatology is different depending on the traumatic event(s). While non-intentional traumas may be treated integrated or in parallel with pain management more complex PTSD conditions related to interpersonal or multiple traumas or adverse childhood experiences probably require specific trauma-focused interventions. In accident-related trauma elevated levels of stress arousal and negative cognitions such as pain-catastrophizing and pain related fear-avoidance beliefs and behaviors may be important mechanisms to target.

In the assessment of chronic pain with comorbid PTSD, it is important to be aware of symptom overlap when screening for PTSD. While some symptoms are truly shared symptoms, others may be false positives related to pain and not PTSD, which is of great importance in treatment planning. Particularly, lack of intrusive symptoms is problematic in relation to exposure-based treatments for PTSD. Type of trauma, time since exposure, prior traumatic experiences, and whether pain and posttraumatic stress symptoms are due to the same event may all have an impact on the association between pain and PTSD symptoms and what should be targeted by interventions. The influence of PTSD symptoms clusters may also be time dependent. Hyperarousal symptoms most influenced pain persistence in the initial months after MVC and may be most important to target with interventions during this time with intrusive symptoms playing a greater role in maintaining or augmenting pain after chronic pain has developed [13].

Future studies should assess the effect of early prevention of comorbid chronic pain and PTSD targeting high risk patients and addressing shared vulnerabilities and potentially mutually maintaining factors. In future studies, we may need to look in other directions than traditional guidelines for treatment of PTSD. Further, we need to aim at more truly personalized treatments [45], also applying designs that focus on the individual rather than group means such as single case

experimental designs [46]. In addition to providing knowledge about personalized treatment approaches, such designs can be helpful in providing knowledge on treatment processes or potential temporal associations between PTSD symptomatology and pain.

Credit author statement

Both Authors Tonny Andersen and Sophie Ravn have contributed equally to all parts of the manuscript, including drafting the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

References

References of particular interest have been highlighted as:

* of special interest
** of outstanding interest

1. Siqveland J, Hussain A, Lindstrøm JC, Ruud T, Hauff E: **Prevalence of posttraumatic stress disorder in persons with chronic pain: a meta-analysis**. *Front Psychiatr* 2017, **8**:164, https://doi.org/10.3389/fpsyt.2017.00164.

2. Nahin R: **Severe pain in veterans: the effect of age and sex, and comparisons with the general population**. *J Pain* 2017, **18**: 247–254, https://doi.org/10.1016/j.jpain.2016.10.021.

3. ** Hadlandsmyth K, Zhuang C, Driscoll MA, Lund BC: **Comorbid chronic pain and post-traumatic stress disorder: current rates and psychiatric comorbidities among U.S. military veterans**. *Mil Med* 2024, **189**:2303–2306, https://doi.org/10.1093/milmed/usae313.

4. Ravn SL, Vaegter HB, Cardel T, Andersen TE: **The role of posttraumatic stress symptoms on chronic pain outcomes in chronic pain patients referred to rehabilitation**. *J Pain Res* 2018, **11**:527–536, https://doi.org/10.2147/JPR.S155241.

5. Ruiz-Párraga GT, López-Martínez AE: **The contribution of posttraumatic stress symptoms to chronic pain adjustment**. *Health Psychol* 2014, **33**:958–967, https://doi.org/10.1037/hea0000040.

6. Åkerblom S, Perrin S, Fischer MR, McCracken LM: **The impact of PTSD on functioning in patients seeking treatment for chronic pain and validation of the posttraumatic diagnostic scale**. *Int J Behav Med* 2017, **24**:249–259, https://doi.org/10.1007/s12529-017-9641-8.

7. Asmundson G, Coons MJ, Taylor S, Katz J: **PTSD and the experience of pain: research and clinical implications of shared vulnerability and mutual maintenance models**. *Can J Psychiatr* 2002, **47**:930–937, https://doi.org/10.1177/070674370204701004.

8. Sharp T, Harvey A: **Chronic pain and posttraumatic stress disorder: mutual maintenance?** *Clin Psychol Rev* 2001, **21**: 857–877, https://doi.org/10.1016/s0272-7358(00)00071-4.

9. Liedl A, Knaevelsrud C: **Chronic pain and PTSD: the perpetual avoidance model and its treatment implications**. *Torture* 2008, **18**:69–76.

10. Scioli-Salter ER, Forman DE, Otis JD, Gregor K, Valovski I, Rasmusson AM: **The shared neuroanatomy and neurobiology of comorbid chronic pain and PTSD: therapeutic implications**. *Clin J Pain* 2015, **31**:363–374, https://doi.org/10.1097/AJP.0000000000000115.

11. * Ravn SL, Hartvigsen J, Hansen M, Sterling M, Andersen TE: **Do post-traumatic pain and post-traumatic stress symptomatology mutually maintain each other? A systematic review of cross-lagged studies**. *Pain* 2018, **159**:2159–2169, https://doi.org/10.1097/j.pain.0000000000001331.

12. Ravn SL, Sterling M, Lahav Y, Andersen TE: **Reciprocal associations of pain and post-traumatic stress symptoms after whiplash injury: a longitudinal, cross-lagged study**. *Eur J Pain* 2018, **22**:926–934, https://doi.org/10.1002/ejp.1178.

13. Feinberg RK, Hu JM, Weaver MA, Fillingim RB, Swor RA, Peak DA, Jones JS, Rathlev NK, Lee DC, Domeier RM, Hendry PL, Liberzon I, McLean SA: **Stress-related psychological symptoms contribute to axial pain persistence after motor vehicle collision: path analysis results from a prospective longitudinal study**. *Pain* 2017, **158**:682–690, https://doi.org/10.1097/j.pain.0000000000000818.

14. Nyland JE, Escolas HD, Archuleta D, Aden JK, Escolas SM: **Attachment style and burn pain**. *J Burn Care Res* 2022, **43**: 1386–1393, https://doi.org/10.1093/jbcr/irac044.

15. Tsur N: **Chronic pain personification following child abuse: the imprinted experience of child abuse in later chronic pain**. *J Interpers Violence* 2022, **37**:NP2516–NP2537, https://doi.org/10.1177/0886260520944529.

16. Ravn SL, Eskildsen NB, Johnsen AT, Sterling M, Andersen TE: **There's nothing broken. You've had a whiplash, that's it: a qualitative study of comorbid posttraumatic stress disorder and whiplash associated disorders**. *Pain Med* 2020, **21**: 1676–1689, https://doi.org/10.1093/pm/pnz369.

17. Ravn SL, Andersen TE: **Exploring the relationship between posttraumatic stress and chronic pain**. *Psychiatr Times* 2020, **37**:19–21.

18. American Psychiatric Association: *Diagnostic and statistical manual of mental disorders*. 5th ed. Virginia: American Psychiatric Association Publishing; 2022.

19. World Health Organization (WHO): **International classification of Diseases**. *Eleventh Revision (ICD-11)* 2019/2021. https://icd.who.int/browse11. Accessed 25 November 2024; 2019/2021.

20. Friedman MJ: **Finalizing PTSD in DSM-5: getting here from there and where to go next**. *J Trauma Stress* 2013, **26**: 548–556, https://doi.org/10.1002/jts.21840.

21. Bovin MJ, Camden AA, Weathers FW: **Literature on DSM-5 and ICD-11: an update**. *PTSD Research Quarterly* 2021, **32**:1–9.

22. Maercker A, Perkonigg A: **Applying an international perspective in defining PTSD and related disorders: comment on Friedman (2013)**. *J Trauma Stress* 2013, **26**:560–562, https://doi.org/10.1002/jts.21852.

23. * Andersen TE, Hansen M, Ravn SL, Vaegter HB: **The association of probable PTSD at baseline and pain-related outcomes after chronic pain rehabilitation: a comparison of DSM-5 and ICD-11 criteria for PTSD**. *Eur J Pain* 2021, **26**:709–718, https://doi.org/10.1002/ejp.1899.

24. Hansen M, Hyland P, Karstoft KI, Vaegter HB, Bramsen RH, Nielsen ABS, Armour C, Andersen SB, Høybye MT, Larsen SK, Andersen TE: **Does size really matter? A multisite study assessing the latent structure of the proposed ICD-11 and DSM-5 diagnostic criteria for PTSD**. *Eur J Psychotraumatol* 2017, **8**, 1398002, https://doi.org/10.1080/20008198.2017.1398002.

25. * Tesarz J, Baumeister D, Andersen TE, Vægter HB: **Pain perception and processing in individuals with posttraumatic stress disorder: a systematic review with meta-analysis**. *Pain Rep* 2020, **17**:e849, https://doi.org/10.1097/PR9.0000000000000849.

26. Hansen M, Hyland P, Armour C, Andersen TE: **Assessing the existence of dissociative PTSD in sub-acute patients of**

whiplash. *J Trauma & Dissociation* 2019, **20**:16–31, https://doi.org/10.1080/15299732.2018.1451805.

27. Kessler RC, Aguilar-Gaxiola S, Alonso J, Benjet C, Bromet EJ, Cardoso G, Degenhardt L, de Girolamo G, Dinolova RV, Ferry F, Florescu S, Gureje O, Haro JM, Huang Y, Karam EG, Kawakami N, Lee S, Lepine J-P, Levinson D, Navarro-Mateu F, Pennell B-E, Piazza M, Posada-Villa J, Scott KM, Stein DJ, Ten Have M, Torres Y, Viana MC, Petukhova MV, Sampson NA, Zaslavsky AM, Koenen KC: **Trauma and PTSD in the WHO world mental health surveys**. *Eur J Psychotraumatol* 2017, **8**, 1353383, https://doi.org/10.1080/20008198.2017.1353383.

28. ** Bussières A, Hanbock MJ, Elklit A, Ferreira ML, Ferreira PH, Stone LS, Wideman TH, Boruff JT, Zoubi FA, Chaudhry F, Tolentino R, Hartvigsen J: **Adverse childhood experience is associated with an increased risk of reporting chronic pain in adulthood: a systematic review and meta-analysis**. *Eur J Psychotraumatol* 2023, **14**, 2284025, https://doi.org/10.1080/20008066.2023.2284025.

29. Lobo JJ, Ayoub LJ, Moayedi M, Linnstaedt SD: **Hippocampal volume, FKBP5 genetic risk alleles, and childhood trauma interact to increase vulnerability to chronic multisite musculoskeletal pain**. *Sci Rep* 2022, **12**:6511, https://doi.org/10.1038/s41598-022-10411-9.

30. ** Goldstein E, McDonnell C, Atchley R, Dorado K, Bedford C, Brown RL, Zgierska AE: **The impact of psychological interventions on posttraumatic stress disorder and pain symptoms: a systematic review and meta-analysis**. *Clin J Pain* 2019, **35**:703–712, https://doi.org/10.1097/AJP.0000000000000730. PMID: 31145146.

31. Andersen TE, Lahav Y, Ellegaard H, Manniche C: **A randomized controlled trial of brief Somatic Experiencing for chronic low back pain and comorbid post-traumatic stress disorder symptoms**. *Eur J Psychotraumatol* 2017, **8**, 1331108, https://doi.org/10.1080/20008198.2017.1331108.

32. Andersen TE, Ellegaard H, Schiøttz-Christensen B, Mejdal A, Manniche C: **Somatic Experiencing® for patients with low back pain and comorbid posttraumatic stress symptoms - a randomised controlled trial**. *Eur J Psychotraumatol* 2020, **18**, 1797306, https://doi.org/10.1080/20008198.2020.1797306.

33. ** Andersen TE, Ravn SL, Armfield N, Maujean A, Requena SS, Sterling M: **Trauma-focused cognitive behavioural therapy and exercise for chronic whiplash with comorbid post-traumatic stress disorder: a randomized controlled trial**. *Pain* 2021, **162**:1221–1232, https://doi.org/10.1097/j.pain.0000000000002117.

34. ** Haun JN, Fowler CA, Venkatachalam HH, Alman AC, Ballistrea LM, Schneider T, Benzinger RC, Melillo C, Alexander NB, Klanchar SA, Lapcevic WA, Bair MJ, Taylor SJ, Murphy JL, French DD: **Outcomes of a remotely delivered complementary and integrative health partnered intervention to improve chronic pain and posttraumatic stress disorder symptoms: randomized controlled trial**. *J Med Internet Res* 2024, **26**, e57322, https://doi.org/10.2196/57322.

35. Beck JG, Coffey SF, Foy DW, Keane TM, Blanchard EB: **Group cognitive behavior therapy for chronic posttraumatic stress disorder: an initial randomized pilot study**. *Behav Ther* 2009, **40**:82–92, https://doi.org/10.1016/j.beth.2008.01.003.

36. Benedict TM, Nitz AJ, Gambrel MK, Louw A: **Pain neuroscience education improves post-traumatic stress disorder, disability, and pain self-efficacy in veterans and service members with chronic low back pain: preliminary results from a randomized controlled trial with 12-month follow-up**. *Mil Psychol* 2024, **36**:376–392, https://doi.org/10.1080/08995605.2023.2188046.

37. Dunne RL, Kenardy J, Sterling M: **A randomized controlled trial of cognitive-behavioral therapy for the treatment of PTSD in the context of chronic whiplash**. *Clin J Pain* 2012, **28**:755–765, https://doi.org/10.1097/AJP.0b013e318243e16b.

38. Groessl EJ, Hafey C, McCarthy A, Hernandez RM, Prado-Nava M, Casteel D, McKinnon S, Chang DG, Ayers CR, Rutledge TE, Lang AJ, Bormann JE: **Yoga plus mantram repetition to reduce chronic pain in veterans with post-traumatic stress disorder: a feasibility trial**. *Glob Adv Integr Med Health* 2023, **12**, 27536130231220623, https://doi.org/10.1177/27536130231220623.

39. * Otis JD, Comer JS, Keane TM, Checko E, Pincus DB: **Intensive treatment of chronic pain and PTSD: the PATRIOT program**. *Behav Sci* 2024, **14**:1103, https://doi.org/10.3390/bs14111103.

40. ** Åkerblom S, Perrin S, Fischer MR, McCracken LM: **Prolonged exposure for pain and comorbid PTSD: a single-case experimental study of a treatment supplement to multiprofessional pain rehabilitation**. *Scand J Pain* 2022, **22**:305–316, https://doi.org/10.1515/sjpain-2021-0100.

41. Levine PA. In *In an unspoken voice: how the body releases trauma and restores goodness*. 1st ed. California: North Atlantic Books; 2010.

42. * Burgess DJ, Calvert C, Hagel Campbell EM, *et al.*: **Telehealth mindfulness-based interventions for chronic pain: the LAMP randomized clinical trial**. *JAMA Intern Med* 2024, **184**:1163–1173, https://doi.org/10.1001/jamainternmed.2024.3940.

43. Sterling M, Smeets R, Keijzers G, Warren J, Kenardy J: **Physiotherapist-delivered stress inoculation training integrated with exercise versus physiotherapy exercise alone for acute whiplash-associated disorder (StressModex): a randomised controlled trial of a combined psychological/physical intervention**. *Br J Sports Med* 2019, **53**:1240–1247, https://doi.org/10.1136/bjsports-2018-100139.

44. Nikles J, Keijzers G, Mitchell G, Farrell SF, Perez S, Schug S, Ware RS, McLean SA, Connelly LB, Sterling M: **Pregabalin vs placebo to prevent chronic pain after whiplash injury in at-risk individuals: results of a feasibility study for a large randomised controlled trial**. *Pain* 2022, **163**:e274–e284, https://doi.org/10.1097/j.pain.0000000000002362.

45. McCracken L: **Personalized pain management: is it time for process-based therapy for particular people with chronic pain?** *Eur J Pain* 2023, **27**:1044–1055, https://doi.org/10.1002/ejp.2091.

46. Krasny-Pacini A, Evans J: **Single-case experimental designs to assess intervention effectiveness in rehabilitation: a practical guide**. *Ann Phys Rehabil Med* 2018, **61**:164–179, https://doi.org/10.1016/j.rehab.2017.12.002.

Further information on references of particular interest

3. ** This study explored prevalence rates of PTSD and chronic pain in all users of the National Veteran Affairs in United States in 2023, a total of 5,846,453 war veterans. They found that a total of 2,091,391 (35.8%) met criteria for chronic pain, while 850,191 (14.5%) met PTSD criteria. Further, 21.6% of those with chronic pain also fulfilled criteria for PTSD, and 53.2% of those with PTSD also met criteria for chronic pain. Further, war veterans with this comorbidity were significantly more likely to be women, urban dwelling, Black or African American, and Latina or Hispanic, and had significantly higher rates of the tested comorbidities compared to war veterans with only chronic pain.

11. * This systematic review – published by the authors of this paper – builds upon the understanding of mutual maintenance between PTSD and chronic pain in comorbid cases. Cross-lagged study designs are one way to empirically test this, which is what we did in this study to assess the evidence for longitudinal reciprocity and potential mediators. Across studies, there was inconsistent evidence of both bidirectional and unidirectional interaction patterns between pain and PTSD symptoms over time, hence not uniformly supporting the theoretical framework of mutual maintenance. Further, hyperarousal and intrusion symptoms were found to potentially be of importance in the cross-lagged relationships.

23. * The current study – that the current authors were also involved in – were conducted in a consecutive cohort of patients with chronic pain. The study found estimated probable PTSD prevalence rates of 15.8% when using the ICD-11 criteria and 16.4% when using DSM-5 criteria. However, diagnostic agreement was only moderate. Probable PTSD using DSM-5 criteria correlated more strongly with psychological distress compared to PTSD

using ICD-11 criteria, and only PTSD according to ICD-11 criteria was associated with poorer outcomes after rehabilitation, underlining the importance of taking the different PTSD conceptualizations into consideration.

25. * This systematic review – that one of the current authors was also involved in – identified studies on experimentally evoked pain perception in individuals with PTSD compared to individuals without PTSD and explored whether the nature of the trauma was associated with pain perception patterns. The study found no main effect of PTSD on any outcome, but when stratified based on trauma type, there were significant differences. Accident-related PTSD was associated with *decreased* pain thresholds, while combat-related PTSD was with *increased*, leaving the authors to conclude that no clear relationship exists, but rather trauma type may affect pain processing differently.

28. ** This systematic review and meta-analysis evaluated the association between exposure to adverse childhood events and later chronic pain and related disability. Based on 85 studies of which 57 were included in the meta-analysis, the authors found that odds of adult chronic pain were significantly higher in individuals exposed to adverse event in childhood and concluded that both single and cumulative adverse events in childhood were significantly associated with adult chronic pain and related disability.

30. ** This study is a systematic review and meta-analysis of psychological treatments' effect on comorbid pain and PTSD symptoms. Data from 10 RCTs were used for the meta-analysis and showed moderate effect for reduced PTSD symptom severity, but non-significant effects for pain intensity and pain interference. The authors concluded that data from the included uncontrolled studies supported these results and that the findings overall indicated that most interventions had greater effect on PTSD symptoms rather than pain symptoms.

33. ** This RCT – that the current authors were also involved in – explored the effect of trauma-focused CBT of the type of prolonged exposure combined with exercise compared to supportive therapy combined with exercise in people with chronic pain and disability after whiplash injury and comorbid PTSD. There were no differences between the interventions on the primary outcome of disability at any time point nor for most of the secondary outcomes with exceptions on PTSD symptoms were in favor of trauma-focused CBT and exercise.

34. ** This waitlist controlled RCT explored effect of a self-directed mobile- and web-based Complementary and integrative health intervention for veterans with comorbid chronic pain and PTSD and their partners and found no significant change in pain, PTSD symptoms, nor most other outcomes. This contrasted with the qualitative findings also reported by the study.

39. * This study provides an overview and session-by-session description of a brief and integrated treatment for chronic pain and comorbid PTSD, also including pilot results on acceptability, feasibility, and efficacy in a small group of war veterans. Further testing of this treatment program will be interesting to follow.

40. ** This is an example of a single case experimental design study, which is the methodology briefly mentioned in the end of the paper. Also, this is to our knowledge the only of these study types in this patient group. The study was conducted in four adults with chronic pain and PTSD. During prolonged exposure treatment, there appeared changes in all outcome variables, but only few reductions pain outcomes. Changes came in different ways and at different times for the participants, which the authors argue highlights the individual nature of change.

42. * This RCT study tested two 8-week telehealth mindfulness-based interventions compared to usual care for veterans with chronic pain. We included this study because participants had high levels of PTSD symptoms, although this was not a criterion for inclusion. The authors found that telehealth mindfulness-based interventions improved pain-related disability and biopsychosocial outcomes compared to usual care.