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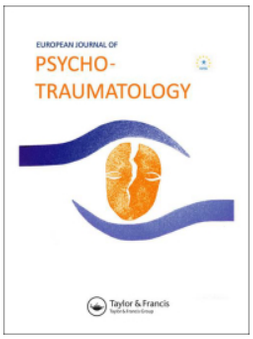

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Validation of the Danish PTSD Checklist for DSM-5 in trauma-exposed chronic pain patients using the Clinician-Administered PTSD Scale for DSM-5

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ABSTRACT

Background: Validation of post-traumatic stress disorder (PTSD) screening tools across various populations to ensure accurate PTSD estimates is important. Because of the high symptom overlap between PTSD and pain, it is particularly important to validate PTSD screening tools in trauma-exposed chronic pain patients.

Objective: The present study is the first seeking to validate the PTSD Checklist for DSM-5 (PCL-5) in a sample of trauma-exposed, treatment-seeking chronic pain patients.

Method: The validation and optimal scoring of the PCL-5 were investigated using the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) in chronic pain patients exposed to traffic or work-related traumas ($n = 84$). Construct validity was investigated using confirmatory factor analyses testing six competing DSM-5 models in a sample of mixed trauma-exposed chronic pain patients ($n = 566$), and a subsample of chronic pain patients exposed to traffic or work-related trauma only ($n = 202$). Furthermore, concurrent validity and discriminant validity were investigated using correlation analysis.

Results: The results showed moderate ($\kappa = .46$) diagnostic consistency between the PCL-5 and the CAPS-5 using the DSM-5 symptom cluster criteria, and the overall accuracy of the scale (area under the curve = .79) was highly acceptable. Furthermore, the Danish PCL-5 showed excellent construct validity both in the full sample and in the subsample of traffic and work-related accidents, with superior fit of the seven-factor hybrid model. Excellent concurrent validity and discriminant validity were also established in the full sample.

Conclusion: The PCL-5 appears to have satisfactory psychometric properties in trauma-exposed, treatment-seeking chronic pain patients.

Validación de la lista de verificación danesa de trastorno de estrés postraumático para el DSM-5 en pacientes con dolor crónico expuestos a trauma que utilizan la escala de TEPT para el DSM-5 administrada clínicamente

Antecedentes: La validación de herramientas de tamizaje de TEPT en varias poblaciones es importante para garantizar una estimación precisa del TEPT. Debido a la gran superposición de síntomas entre TEPT y dolor, es especialmente importante validar las herramientas de detección de TEPT en pacientes con dolor crónico expuestos a traumas.

Objetivo: El presente estudio es el primero que busca validar la lista de verificación de TEPT-5 (PCL-5, por sus siglas en inglés) en una muestra de pacientes con dolor crónico expuestos a trauma que buscan tratamiento.

Método: La validación y puntuación óptima del PCL-5 se investigaron utilizando la Escala de TEPT administrada clínicamente para el DSM-5 (CAPS-5, por sus siglas en inglés) en pacientes con dolor crónico expuestos a traumas relacionados con el tráfico o trabajo ($N = 84$). La validez de constructo se investigó utilizando análisis factorial confirmatorio probando seis modelos DSM-5 competitivos en una muestra de pacientes con dolor crónico expuestos a trauma mixto ($N = 566$), y una submuestra de pacientes con dolor crónico expuestos a trauma relacionado con el tráfico o trabajo únicamente ($n = 202$). Adicionalmente, se investigó la validez concurrente y discriminante mediante análisis de correlación.

Resultados: Los resultados mostraron una consistencia diagnóstica moderada ($k = 0,46$) entre el PCL-5 y el CAPS-5 utilizando los criterios de grupos sintomáticos del DSM-5, y la precisión general de la escala (AUC = 0,79) fue altamente aceptable. Además, el PCL-5 danés mostró una excelente validez de constructo tanto en la muestra completa como en la submuestra de accidentes de tráfico y relacionados con el trabajo con un ajuste superior del modelo

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关键词
PTSD; 慢性疼痛; PCL-5; 验证; 创伤

HIGHLIGHTS

- The present study is the first seeking to validate the PCL-5 using the CAPS-5 in chronic pain patients following traffic and work-related injury.
- The results showed moderate diagnostic consistency and acceptable overall accuracy using the DSM-5 criteria.
- Excellent construct, concurrent, and discriminant validity was established in chronic pain patients following mixed traumatic exposure and traffic and work-related trauma only.

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híbrido de siete factores. También se estableció una excelente validez concurrente y de discriminación en la muestra completa.
Conclusión: En conclusión, el PCL-5 parece tener propiedades psicométricas satisfactorias en pacientes con dolor crónico expuestos a trauma que buscan tratamiento.

在创伤暴露慢性疼痛患者中使用 DSM-5 临床用 PTSD 量表对丹麦语版DSM-5创伤后应激障碍清单的验证

背景：在不同人群中验证 PTSD 筛查工具以确保准确的 PTSD 估计非常重要。 由于 PTSD 和疼痛之间的症状高度重叠，因此在遭受创伤的慢性疼痛患者中验证 PTSD 筛查工具尤为重要。
目的：本研究是第一项寻求在创伤暴露寻求治疗的慢性疼痛患者样本中验证 PTSD检查表5 (PCL-5) 的研究。
方法：在暴露于交通或工作相关创伤的慢性疼痛患者 ($N = 84$) 中，使用 DSM-5 临床用 PTSD 量表 (CAPS-5) 考查了 PCL-5 的验证和最佳评分。 使用验证性因素在混合创伤暴露慢性疼痛患者样本（$N = 566$）和仅暴露于交通或工作相关创伤的慢性疼痛患者子样本中检验六个竞争 DSM-5 模型（$n = 202$）来考查构造效度。 此外，使用相关分析研究了同时效度和区分效度。
结果：结果显示，使用 DSM-5 症状簇标准，PCL-5 和 CAPS-5 之间的诊断一致性中等（$k = 0.46$），量表的总体准确性（AUC = 0.79）是高度可接受的。 此外，在交通和工作相关事故的全样本和子样本中，丹麦语 PCL-5 在拟合更佳的七因素混合模型中均显示出出色的结构效度。 在完整样本中确定了出色的同时效度和区分效度。
结论：总之， PCL-5 似乎在寻求治疗的创伤暴露慢性疼痛患者中具有令人满意的心理测量特性。

1. Introduction

Exposure to potentially traumatic events is common and is associated with an increased risk of a wide range of psychological disorders, including post-traumatic stress disorder (PTSD) (Kessler et al., 2017). Validation of PTSD screening tools is important across various populations and settings to ensure the accurate measurement of PTSD in specific populations (Hall et al., 2019; Murphy et al., 2017). Indeed, it is of particular importance in trauma-exposed chronic pain patients, for multiple reasons. Comorbid PTSD has been identified in up to 57% of chronic pain patients (Siqveland et al., 2017). Not only is there a high comorbidity, but chronic pain and PTSD have also been suggested to be interdependent conditions that mutually maintain and exacerbate one another (Brennstuhl et al., 2015; Sharp & Harvey, 2001). However, there is also a high symptom overlap between the two conditions. This increases the risk of false positives in assessments of PTSD (Hansen et al., 2021), probably, in part, as a result of patients responding to non-specific items of PTSD screening questionnaires based on their pain and disability (Bunzli et al., 2019). It is therefore highly important to validate PTSD screening tools specifically in populations with chronic pain.

According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association, 2013), PTSD is a disorder characterized by 20 symptoms belonging to four symptom clusters; namely, intrusion (B1–B5), avoidance (C1–C2), negative alterations in cognitions and mood (D1–D7), and alterations in arousal and reactivity (E1–E6). In particular, the symptom clusters D and E may be prone to resulting in false positives owing to overlapping symptoms with chronic pain. Examples of overlapping symptoms are 'loss of interest in activities', 'feeling irritable or angry or acting out', 'having difficulties concentrating', and 'trouble falling or staying asleep'. The PTSD Checklist for DSM-5 (PCL-5) (Weathers, Litz, et al., 2013) is one of the most commonly used self-report measurements of PTSD. The PCL-5 consists of 20 items corresponding to the 20 DSM-5 PTSD symptoms, allowing for screening and providing an estimated PTSD diagnosis. The PCL-5 was originally developed in English but has since been translated into numerous languages (e.g. Brazilian, by Pereira-Lima et al., 2019; German, by Krüger-Gottschalk et al., 2017; Shona, by Verhey et al., 2018; and Tagalog, by Hall et al., 2019), including Danish (Hansen et al., 2017). The psychometric properties of the PCL-5 and the establishment of precise cut-off scores using clinical structured interviews (for an overview, see Roberts et al., 2021) or confirmatory factor analysis (CFA) (e.g. Armour et al., 2016; Hansen et al., 2017) have been assessed across various populations, although rarely in a clinical sample of trauma-exposed chronic pain patients. As far as we know, no studies have validated the Danish PCL-5 using diagnostic interviews, such as the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) (Weathers, Blake, et al., 2013), in a clinical sample of trauma-exposed chronic pain patients.

Research seeking to validate the PCL-5 using diagnostic interviews has resulted in different cut-off scores on the PCL-5 being identified across various populations and settings (for an overview, see Roberts et al., 2021). Indeed, the optimal cut-off scores has been found to vary from 25 in a sample of Filipino migrant workers (Hall et al., 2019) to 43–44 in a UK sample of trauma-exposed mental health service users (Roberts et al., 2021). The

establishment of precise cut-off scores is therefore crucial for ensuring as accurate as possible estimation of PTSD across various populations (Hall et al., 2019; Murphy et al., 2017). As mentioned, this is particularly evident in trauma-exposed chronic pain patients because of the overlap between symptoms of pain and PTSD.

Numerous studies have tested the latent structure of DSM-5 PTSD using CFA across various trauma populations (for a review, see Armour et al., 2016; Hansen et al., 2017). Studies have supported the DSM-5 PTSD four-factor structure of PTSD or five alternative models, of which, in particular, the Anhedonia model and the Hybrid model have shown promising results (Armour et al., 2016) (see Table 1 for the six model specifications). As far as we know, only one study has investigated the latent structure of PCL-5 using CFA in trauma-exposed chronic pain patients, with the results showing a superior fit for the seven-factor Hybrid model (Hansen et al., 2017). The present study is the first one seeking to validate the Danish PCL-5 using diagnostic interviews (i.e. the CAPS-5) (Weathers, Blake, et al., 2013) in a clinical sample of trauma-exposed chronic pain patients. As far as we know, the present study is also the first study seeking to validate the PCL-5 specifically following traffic and work-related traumas.

The present study has multiple objectives. The first objective was to investigate the diagnostic accuracy of the Danish PCL-5 in chronic pain patients exposed to traffic or work-related traumas using the CAPS-5. Exposure to traffic and work-related traumas was selected, as it has been reported as the most common cause of comorbid PTSD in chronic pain patients (Andersen et al., 2014). Based on prior research, we were uncertain about which optimal cut-off score we would identity for the PCL-5 in the present study. The second objective was to investigate the construct validity of the PCL-5 using CFA, testing the six competing DSM-5 models in both a full sample of trauma-exposed clinical chronic pain patients and a subsample of chronic pain patients exposed to traffic and work-related traumas only. Based on prior research, we expected that the seven-factor Hybrid DSM-5 PTSD model would provide the best fit. The third objective was to investigate the concurrent validity (i.e. correlations with depression, anxiety, and another PTSD measurement) as well as discriminant validity (i.e. correlation to pain-related avoidance vs PTSD-related avoidance) of the PCL-5 in the full sample. Based on prior research, we expected that the PCL-5 scores would be positively and moderately correlated with depression, anxiety, and another PTSD measurement, but only weakly correlated with pain-related fear and avoidance (e.g. Bovin et al., 2016; Hall et al., 2019; Hansen et al., 2021; Roberts et al., 2021; Wortmann et al., 2016).

2. Method

2.1. Participants

To investigate the different objectives, the present study used data from a sample from the University Hospital Interdisciplinary Pain Center, Odense, Denmark, and a sample from a rehabilitation hospital. The second and third objectives were investigated using only data from patients referred to the Pain Center. Out of 1623 patients responding to the questionnaire, a total of 650 (40.1%) reported exposure to a traumatic event with indication of a specific known index trauma. A total of 42 patients (6.5%) had more than 20% missing data on the selected combination of variables and were excluded from the analyses. The final sample from the Pain Center therefore comprised 608 participants (32.1% males, *M* age = 50.46 years, *SD* = 13.93, range 18–98), of whom 219 indicated traffic or work-related accidents as the index trauma. There were a limited amount of missing data (0.9–2.0%) missing completely at random [Little's MCAR test $\chi^2(9318) = 9367.28$, $p = .357$]. The estimated PTSD prevalence rates according to the diagnostic criteria for the PCL-5 were 25.3% ($n = 143$) in the full sample and 22.3% ($n = 45$) in the traffic and work-related accident subsample. The most common types of traumatic exposure reported as the index trauma in the full sample were traffic or work-related accident (36.0%, $n = 219$), life-threatening illness (25.0%, $n = 152$), sudden accidental death (24.8%, $n = 151$), assault (9.7%, $n = 59$), violence (4.3%, $n = 26$), and disaster (0.2%, $n = 1$).

To investigate the first objective, patients from the Pain Center reporting an index trauma related to traffic or work-related accidents were consecutively invited to participate in a diagnostic interview ($n = 38$, 55.3% males, *M* age = 44.8 years, *SD* = 11.1, range = 22–63). In addition, patients with chronic whiplash-related pain meeting the diagnostic criteria for PTSD measured by the CAPS-5 from a rehabilitation hospital ($n = 46$, 30.4% males, *M* age = 35.9 years, *SD* = 11.0, range = 20–63) were included, leaving an eligible sample for the first objective size of 84. Of note, there were no missing data in the subsample from the Pain Center; however, the sample from the rehabilitation hospital originally consisted of 54 participants, of whom eight were excluded owing to missing items on the PCL-5, leaving a subsample of 46 participants to be used in this study.

2.2. Procedure

For the Pain Center data set, data were collected from patients who were referred to assessment and treatment at the University Hospital Interdisciplinary Pain Center, Odense, Denmark, during 2018. All referred patients were invited to participate in an electronic questionnaire survey (Clinical Pain Registry, PainData) before the first consultation at the pain clinic. The questionnaire was

Table 1. PTSD Checklist for DSM-5 (PCL-5) item mapping for the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) post-traumatic stress disorder (PTSD) factor models.

Symptoms	DSM-5 (4 factors)	Dysphoria (4 factors) (Miller et al., 2013)	Dysphoric arousal (5 factors) (Elhai et al., 2011)	Anhedonia (6 factors) (Lui et al., 2014)	External behaviours (6 factors) (Tsai et al., 2014)	Hybrid (7 factors) (Armour et al., 2015)
B1: Memories	I	I	I	I	I	I
B2: Nightmares	I	I	I	I	I	I
B3: Flashbacks	I	I	I	I	I	I
B4: Emotional reactivity	I	I	I	I	I	I
B5: Physiological reactivity	I	I	I	I	I	I
C1: Internal avoidance	A	A	A	A	A	A
C2: External avoidance	A	A	A	A	A	A
D1: Amnesia	NACM	D	NACM	N	NACM	N
D2: Negative beliefs	NACM	D	NACM	N	NACM	N
D3: Blame	NACM	D	NACM	N	NACM	N
D4: Negative feelings	NACM	D	NACM	N	NACM	N
D5: Loss of interest	NACM	D	NACM	AN	NACM	AN
D6: Distant	NACM	D	NACM	AN	NACM	AN
D7: Numbing	NACM	D	NACM	AN	NACM	AN
E1: Irritability	AAR	D	DA	DA	EB	EB
E2: Risky behaviour	AAR	D	DA	DA	EB	EB
E3: Hypervigilance	AAR	AAR	AA	AA	AA	
E4: Easily startled	AAR	AAR	AA	AA	AA	AA
E5: Concentration	AAR	D	DA	DA	DA	DA
E6: Sleep disturbance	AAR	D	DA	DA	DA	DA

Note. I, intrusions; A, avoidance; NACM, negative alterations in cognition and mood; AAR, alterations in arousal and reactivity; D, dysphoria; DA, dysphoric arousal; AA, anxious arousal; AN, anhedonia; EB, externalizing behaviours; N, negative affect.

sent via e-Boks (the channel for official communication to citizens from the Danish State and municipalities) and were replied to prior to starting treatment at the Pain Center. During completion of the questionnaires, patients are invited to give consent so that the questionnaire data can be stored in the PainData research database and used for later research. The Danish Data Protection Agency approved the data collection (18/35221). The collected data are protected in accordance with the Act on the Processing of Personal Data (Act No. 429 of 31/05/2000) and the Law on the Status of Patients (Act No. 482 of 01/07/1998). As treatment was not affected by participation in the study, under Danish law, this study did not need ethics approval (Act on Research Ethics Review of Health Research Projects, October 2013, Section 14.2).

For the rehabilitation hospital data set, data were collected from patients participating in a treatment study taking place at the Specialized Hospital for Polio and Accident Victims, Denmark, between 2015 and 2018. Data included in the present study are the baseline data, which were collected prior to commencing treatment. The Regional Science Ethics Committee approved the study (J.nr. S-20130103).

2.3. Measures

2.3.1. Trauma and PTSD-related measures

Traumatic exposure was assessed using seven categories, which were selected based on prior research, research experiences, and data sets indicating that these categories are the most common types of traumatic exposure in pain patients (Andersen et al. 2012, 2014). The seven categories were: life-threatening illness, natural disaster, accident (work or traffic), sexual assault, physical or mental violence, sudden accidental death, and other.

The DSM-5 PTSD symptoms were assessed in relation to the traumatic event indicated as the most distressing one (i.e. the index trauma) using the PCL-5 (Weathers, Litz, et al., 2013). The PCL-5 is a 20-item measurement of each of 20 DSM-5 symptoms belonging to the four DSM-5 PTSD symptom clusters, rated on a five-point Likert-type scale from 0 to 4 (0 = not at all to 4 = extremely), indicating how much a specific symptom has bothered the respondent in the past month. The scale can be used to generate a probable estimated diagnosis of DSM-5 PTSD following an initial cut-off score of $\geq$ 31–33 (Bovin et al., 2016) or according to the diagnostic criteria with endorsement of at least one symptom of B, one symptom of C, two symptoms of D, and two symptoms of E, indicated by a score $\geq$ 2 ('moderately'). In general, the PCL-5 has previously shown acceptable validity and reliability (Bovin et al., 2016). In the present study, the internal reliability (Cronbach's α) was .95 for the total score in the full sample. The PCL-5 was translated into Danish following international guidelines for translations of psychological tests (Hambleton, 2005; van Ommeren et al., 1999). The procedure included independent

forward and backwards translation using the committee approach, the use of a research expert group, and focus group interviews.

PTSD symptoms were also assessed by the Danish version of the CAPS-5 (Weathers, Blake, et al., 2013, translated by Parding, Kristensen, Bak, & Volder, 2016), which is a structured diagnostic interview designed to assess DSM-5 PTSD. Each symptom is assessed on its intensity and frequency in the past month and combined into a symptom severity rating using a five-point Likert-type scale from 0 to 4 (0 = absent to 4 = extremely/incapacitating). The PCL-5 was administered first, followed by the CAPS-5 on the same day, to ensure that both instruments referenced the same time and index trauma. The CAPS-5 interviews were administered by psychology graduate students, who received initial training from the authors and regular supervision throughout the data collection procedure at the University Hospital Pain Center, Odense, including joint ratings of the first five video-taped interviews resulting in no disagreements regarding diagnostic status, while three authorized clinical psychologists carried out the interviews at the rehabilitation centre. The interviewers were blinded to the participants' scores on the PCL-5.

2.3.2. Measures used for discriminant and concurrent validity

The discriminant validity and concurrent validity of the PCL-5 were assessed using the following measurements: the Generalized Anxiety Disorder-7 (GAD-7) (Spitzer et al., 2006) to assess symptoms of anxiety, the Patient Health Questionnaire-9 (PHQ-9) (Kroenke & Spitzer, 2002) to assess symptoms of depression, the International Trauma Questionnaire (ITQ) (Cloitre et al., 2018; Hansen et al., 2021) to assess PTSD with another measurement, and the Tampa Scale for Kinesiophobia (TSK) (Kori et al., 1990) to assess fear of reinjury due to movement. The GAD-7 comprises seven items and the PHQ-9 comprises nine items rated on a Likert-type scale from 0 to 3 (0 = not at all to 3 = nearly every day). The GAD-7 has been found to be a valid and reliable measurement across both general and psychiatric settings (Hinz et al., 2017; Rutter & Brown, 2017). The PHQ-9 has been used in both epidemiological studies and clinical populations (Kroenke et al., 2010). The ITQ PTSD subscale assesses International Classification of Diseases, 11th revision (ICD-11) PTSD with six items rated on a five-point Likert-type scale from 0 to 4 (0 = not at all to 4 = extremely) (Cloitre et al., 2018). Three of the six items on the ITQ are identical to the PCL-5 and therefore were not used in the further analyses. The ITQ has been validated across various populations, including chronic pain patients (Hansen et al., 2021) The TSK comprises 17 items rated on a four-point Likert-type scale from 1 to 4 (1 = strongly disagree to 4 = strongly agree). The TSK is commonly used in chronic pain samples and has shown good construct and predictive validity (Roelofs et al., 2004). In the present study, the Cronbach's α values were .88, .82, .89, and .87 for the GAD-7, PHQ-9, ITQ, and TSK total scores, respectively.

2.4. Data analyses

The statistical analyses were divided into three steps according to the three objectives.

2.4.1. Diagnostic accuracy of the PCL-5

Diagnostic accuracy was assessed by receiver operating characteristics (ROC) analysis at different cut-off criteria in the combined sample of patients with diagnostic interviews, using SPSS 26. The CAPS-5 was used as the gold-standard reference against which the PCL-5 was assessed. The prevalence of PTSD at the different cut-off values was assessed in relation to sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall performance. An area under the curve (AUC) of .70–.80 was considered acceptable and a value > .80 as excellent (Mandrekar, 2010). The optimal cut-off criterion was calculated by Youden's J [J = (Sensitivity + Specificity) − 1]. The positive likelihood ratio (+LR) and negative likelihood ratio (−LR) were calculated as follows: +LR = Sensitivity/(1 − Specificity) and −LR = (1 − Sensitivity)/Specificity. Finally, diagnostic agreement with the CAPS-5 interview was assessed by Cohen's kappa (κ) statistics, with a κ value > .80 indicating almost perfect agreement, .61–.80 substantial agreement, and .41–.60 moderate agreement (Landis & Koch, 1977).

2.4.2. Construct validity of the PCL-5

CFA was used to investigate the construct validity of the PCL-5 testing the six DSM-5 PTSD models (Table 1), performed in Mplus 7.4 (Muthén & Muthén, 2012), using the mean and variance-adjusted weighted least squares (WLSMV) estimator, as recommended for ordinal response scales (Flora & Curran, 2004). The six different models were estimated across the full sample and the subsample of victims of traffic and work-related accidents. The following model fit statistics were used to evaluate overall model fit: root mean chi-squared result, Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and root mean square error of approximation (RMSEA). Good model fit was indicated by a non-significant chi-squared result. For the CFI and TLI, values > .95 indicated excellent fit and values > .90 indicated adequate fit. Changes in the RMSEA results were used to compare alternative models, with changes > .015 indicating significant changes in the respective models (Chen et al., 2008). For the CFA, only participants with complete information were used. In the traffic

and work-related accident subsample, there were complete data on 92.2% of 219 participants ($n = 202$), and in the full mixed sample there were complete data on 93.1% of the 608 participants ($n = 566$).

2.4.3. Concurrent and discriminant validity of the PCL-5

A series of Spearman's rho (ρ) correlation analyses was computed to test concurrent and discriminant validity in the full mixed sample only ($n = 608$), using SPSS 26.

3. Results

3.1. Diagnostic accuracy

Out of the 84 participants with diagnostic interviews, 60.7% ($n = 51$) met the DSM-5 diagnostic criteria for PTSD according to the CAPS-5 interview. As shown in Figure 1, a satisfactory overall accuracy of the PCL-5 was found (AUC = .79).

The performance of the PCL-5 at the different cut-off criteria compared to the CAPS-5 is presented in Tables 2 and 3. The prevalence of PTSD at the different cut-off criteria ranged from 48.8% (cut-off score 38) to 70.2% (cut-off score 26). According to Youden's *J,* the optimal cut-off was achieved using the DSM-5 diagnostic criteria for the PCL clusters. Using the diagnostic criteria as the cut-off criterion resulted in 56.0% qualifying for possible PTSD, a prevalence close to the true prevalence of 60.7% as defined by the diagnostic interview. Using the diagnostic cluster criteria, the LR+ was 2.78, indicating that about 1 in 1.2 with a positive test do have PTSD. The LR− was 0.34, indicating that about 1 in 1.5 with a negative test do not have PTSD. The diagnostic agreement between the PCL-5 using the cluster criteria and the CAPS-5 interview was $\kappa = .46$, indicating moderate agreement.

3.2. Construct validity

The model fit statistics of the six tested models of the PCL-5 across the subsample of accident victims and full sample of mixed traumatic exposure are provided in Table 4. All models provided good fit to the data. However, the Hybrid model provided an overall better fit according to the different model fit statistics, including changes in RMSEA > .015 compared to the other tested models, except for the Anhedonia model, which provided similar fit. To further compare the model fit of the Anhedonia model and the Hybrid model, we therefore used the MLR estimator to calculate a Bayesian information criterion (BIC) (Schwarz, 1978) value for these two models, as the lowest BIC value is considered the best fit, with a 10-point difference indicating a significant difference (Raftery, 1995). The BIC values for the Anhedonia and Hybrid models were 31,342.054 and 31,261.107, respectively, indicating superior fit of the Hybrid model. The standardized factor loadings for all factors across the two hybrid models were all positive and strong, ranging between .54 and .96 ($p < .001$). Standardized factor correlations were also all positive and moderate to strong, ranging from .45 to .96 ($p < .001$).

3.3. Concurrent and discriminant validity

The mean scores, standard deviations, and range of measurements used to test concurrent and discriminant validity were as follows: PCL-5 total score ($M = 23.30$, $SD = 18.42$, range = 0–80), GAD-7 total score ($M = 6.13$, $SD = 5.00$, range = 0–21), PHQ-9 total score ($M = 10.51$, $SD = 5.76$, range = 0-27), and TSK total score ($M = 40.55$, $SD = 7.99$, range = 19–66). The PCL-5 total score correlated strongly and positively with the GAD-7 total score (Spearman's $\rho = .61$, $p < .001$), the PHQ-9 total score ($\rho = .55$ $p < .001$), and the three ITQ items ($\rho = .75$, $p < .001$). Finally, the PCL-5 total score correlated weakly and positively with the TSK total score ($\rho = .24$, $p < .001$).

4. Discussion

The present study is the first to validate the PCL-5 in Danish in a sample of treatment-seeking chronic pain patients exposed to traffic and work-related injury, using diagnostic interviews. Overall, the results suggest that the diagnostic consistency between the CAPS-5 and the PCL-5 using the DSM-5 symptom cluster criteria was moderate and the overall accuracy of the scale was highly acceptable. Furthermore, the Danish PCL-5 showed excellent construct validity in both the full sample and the subsample of traffic and work-related accidents, as well as excellent concurrent and discriminant validity in the full sample.

In the present study, the combined results suggested that optimal overall balancing between sensitivity, specificity, PPV, and NPV was found using the diagnostic criteria rather than a cut-off score on the PCL-5. Furthermore, applying the diagnostic criteria resulted in similar estimated prevalence rates between the PCL-5 (56.0%) and CAPS-5 (60.7%). This is satisfactory and in contrast to prior pain studies, which indicated a tendency for self-report measurements to be overinclusive compared to diagnostic interviews (Siqveland et al., 2017). Both false positives and false negatives pose a specific challenge in relation to pain and PTSD owing to the potential overlap between symptoms. False negatives would be problematic as PTSD, despite its high comorbidity, would be overlooked in pain rehabilitation treatment, whereas false positives would also challenge the treatment focus (Andersen et al., 2022; Ravn & Andersen, 2020).

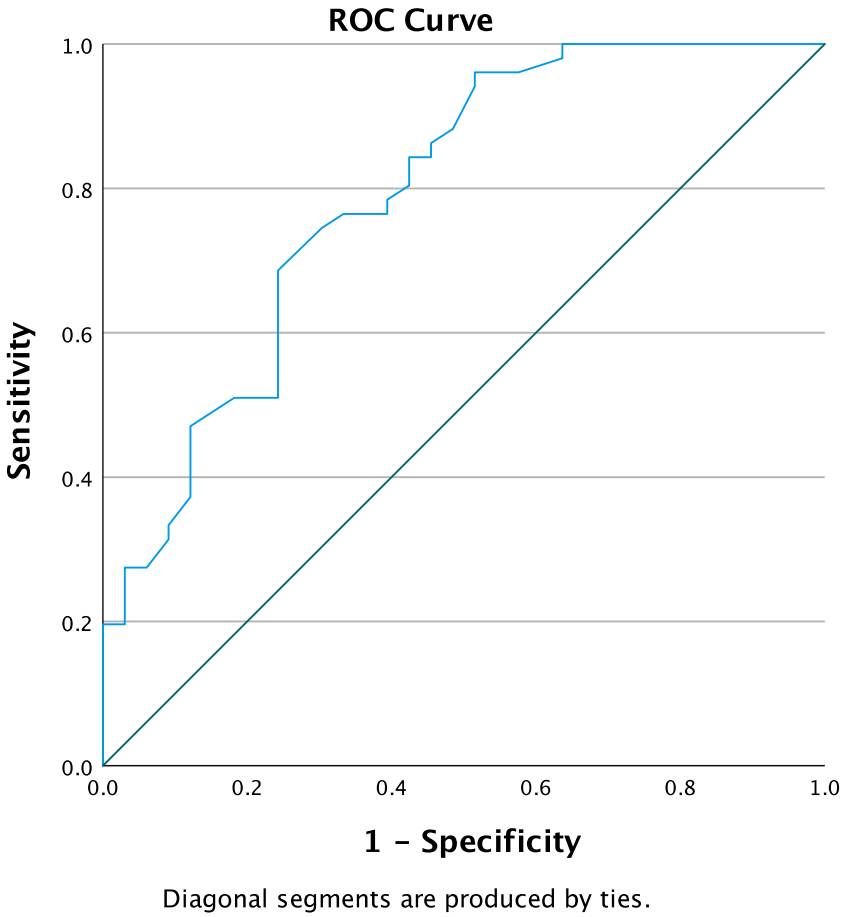

Figure 1. Receiving operating characteristics (ROC) curve for the PTSD Checklist for DSM-5 (PCL-5) relative to the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) interview. Accuracy, as represented by the area under the curve, is .79 (95% CI = .69–.89).

As expected, the overall best model fit statistics of the CFAs indicated that the seven-factor Hybrid model best represented the latent structure of the Danish PCL-5. This is in accordance with a prior study using the Danish PCL-5, which also found that the Hybrid model provided the best fit in treatment-seeking chronic pain patients (Hansen et al., 2017). Furthermore, as expected, the PCL-5 correlated strongly with anxiety, depression, and another PTSD measurement (e.g. Bovin et al., 2016; Hall et al., 2019; Roberts et al., 2021; Wortmann et al., 2016), and weakly with fear of movement, indicating good concurrent and discriminant validity. The correlation between PCL-5 and the other PTSD measurement was stronger than the correlations between PCL-5 and anxiety and depression, which further supported discriminant and concurrent validity.

The results of the present study have several clinical implications. When combined, the results support the PCL-5 and point to its being a valuable screening tool for DSM-5 PTSD following traffic and work-related injuries. In contrast to existing studies seeking to validate the PCL-5 using diagnostic interviews, our results do not point to the use of a cut-off score ranging from 25 to 43. Instead, our results indicate that using the diagnostic criteria as a scoring algorithm for the PCL-5 yielded the best results. This is also in accordance with the recommended scoring key; however, the use of cut-off scores is also recommended. In general, the use of cut-off scores is problematic, as it is theoretically possible for a participant to meet a cut-off score on a scale for PTSD without meeting the required diagnostic criteria. There are several possible explanations for why our study yielded different results from prior research. One possible explanation includes the use of samples exposed to different traumatic events, which underlines the importance of validating PTSD screening tools across various settings to ensure the accurate measurement of PTSD in specific populations. Furthermore, methodological differences may explain some of the differences, as not all prior studies used the CAPS-5 as the diagnostic interview [e.g. the Mini-International Neuropsychiatric Interview (MINI) for DSM-5 was used in the Hall et al., 2019 study, the Trauma- and Stressor-Related Disorders module for the Structured Clinical Interview for DSM-5 Disorders – Clinician Version (SCID-5-CV) in the Pereira-Lim et al. 2019 study, and the PTSD Symptom Scale – Interview (PSS-I) in the Wortmann et al., 2016 study], and not all studies assessed the diagnostic utility of the required diagnostic criteria but, rather, solely investigated cut-off scores (e.g. Hall et al., 2019; Murphy et al., 2017).

Table 2. Post-traumatic stress disorder (PTSD) prevalence rates for different cut-off scores.

Cut-off	Prevalence	True positives	False positives	True negatives	False negatives
Interview	51 (60.7%)	51	–	33	–
PCL-5 cluster	**47 (56.0%)**	**38**	**9**	**24**	**13**
26	59 (70.2%)	44	15	18	7
27	58 (69.0%)	43	15	18	8
28	57 (67.9%)	43	14	19	8
29	57 (67.9%)	43	14	19	8
30	55 (65.5%)	41	14	19	10
31	53 (63.1%)	40	13	20	11
32	52 (61.9%)	39	13	20	12
33	52 (61.9%)	39	13	20	12
34	50 (59.5%)	39	11	22	12
35	48 (57.1%)	38	10	23	13
36	43 (51.2%)	35	8	25	16
37	42 (50.0%)	34	8	25	17
38	41 (48.8%)	33	8	25	18

Note. Interview = Clinician-Administered PTSD Scale for DSM-5 (CAPS-5); all cut-offs = PTSD Checklist for DSM-5 (PCL-5) score; PCL-5 cluster = at least one item within each PTSD symptom cluster (intrusion, avoidance), and at least two items within (negative cognitions and mood, hyperarousal) (PCL-5).

However, as the present study is the first to validate the PCL-5 using CAPS-5 following traffic and work-related injury in trauma-exposed chronic pain patients, and variation has been found across different traumatic exposures, future studies are needed to replicate the results following similar traumatic exposures as well as a wider range of traumatic exposures, including more complex traumas than those that have already been investigated (Roberts et al., 2021). However, the results appear to underline the importance of validating PTSD screening tools across various traumatic exposures to ensure the accurate measurement of PTSD in specific populations.

4.1. Limitations

Although the results of the present study are promising, they need to be interpreted with several limitations in mind. First, the sample in the present study was a clinical sample of treatment-seeking chronic pain patients exposed to the most common forms of traumatic exposure in pain patients, and it is currently unclear whether the results can be generalized to a wider range of populations, including a wider range of pain patients and traumatic exposures. Cross-validation studies of our results across a wider range of pain patients and traumatic exposures are therefore needed to ensure generalizability. Secondly, although the combined sample size was satisfactory in relation to the diagnostic interviews, the numbers of true negative and false positives were low. It is possible that this is due to the use of a subsample solely meeting the diagnostic criteria and thus producing a high number of true positives. A larger sample for the CAPS-5 interview is therefore needed to calculate specificity and NPV with higher accuracy. Thirdly, unfortunately, we were unable to investigate test–retest reliability in the present study. Finally, Cohen's guidelines for interpreting kappa values have been criticized for being too lenient (McHugh, 2012). This is problematic as our study found only moderate diagnostic agreement between the PCL-5 and the CAPS-5. Although several measurements were taken to ensure sufficient training of the interviewers, biases cannot be completely ruled out. Future research should focus on identifying and limiting potential biases to diagnostic agreement in general, and specifically in relation to chronic pain patients. These biases may be associated with the nature of the conducted diagnostic interviews as well as self-reporting of PTSD symptoms (e.g. whether the numbers of self-reported false positives or false negatives are associated with symptom overlap with chronic pain).

Table 3. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for different cut-off scores.

Cut-off	Sensitivity	Specificity	PPV	NPV	Overall performance
PCL cluster	**0.75**	**0.73**	**0.81**	**0.65**	**0.74**
26	0.86	0.55	0.75	0.72	0.74
27	0.84	0.55	0.74	0.69	0.73
28	0.84	0.58	0.75	0.70	0.74
29	0.84	0.58	0.75	0.70	0.74
30	0.80	0.58	0.75	0.66	0.71
31	0.78	0.61	0.75	0.65	0.71
32	0.76	0.61	0.75	0.63	0.70
33	0.76	0.61	0.75	0.63	0.70
34	0.76	0.67	0.78	0.65	0.73
35	0.75	0.70	0.79	0.64	0.73
36	0.69	0.76	0.81	0.61	0.71
37	0.67	0.76	0.81	0.60	0.70
38	0.65	0.76	0.80	0.58	0.69

Note. Interview = Clinician-Administered PTSD Scale for DSM-5 (CAPS-5); all cut-offs = PCL score; PCL cluster = at least one item within each PTSD symptom cluster (intrusion, avoidance), and at least two items within (negative cognitions and mood, hyperarousal) with a score ≥ 2 on the PTSD Checklist for DSM-5 (PCL-5).

5. Conclusion

The present study is the first to validate the PCL-5 in Danish in a sample of treatment-seeking chronic pain patients exposed to traffic and work-related injury using clinical interviews. While it is generally important that PTSD screening tools are validated

Table 4. Model fit statistics for the alternative models of Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) post-traumatic stress disorder (PTSD) symptoms following mixed traumatic exposure and accidents.

	χ^2	*df*	*p*	CFI	TLI	RMSEA (90% CI)
Full mixed sample ($n = 566$)						
DSM-5 model	855.429	164	.000	.958	.952	.086 (.081–.092)
Dysphoria model	777.476	164	.000	.963	.957	.081 (.076–.087)
Dysphoric arousal model	705.696	160	.000	.967	.961	.078 (.072–.084)
Anhedonia model	457.390	155	.000	.982	.978	.059 (.053–.065)
External behaviours model	638.290	155	.000	.971	.964	.074 (.068–.080)
Hybrid model	**338.074**	**149**	**.000**	**.987**	**.983**	**.051 (.044–.058)**
Accident sample ($n = 202$)						
DSM-5 model	383.812	164	.000	.961	.955	.081 (.071–.092)
Dysphoria model	347.384	164	.000	.968	.962	.074 (.064–.085)
Dysphoric arousal model	318.258	160	.000	.972	.967	.070 (.059–.081)
Anhedonia model	250.136	155	.000	.983	.979	.055 (.042–.067)
External behaviours model	301.939	155	.000	.974	.968	.069 (.057–.080)
Hybrid model	**223.064**	**149**	**.000**	**.987**	**.983**	**.050 (.035–.063)**

Note. Estimator = mean and variance-adjusted weighted least squares (WLSMV); χ^2, chi-squared goodness-of-fit statistic; *df*, degrees of freedom; *p*, statistical significance; CFI, Comparative Fit Index; TLI, Tucker–Lewis Index; RMSEA (90% CI), root mean square error of approximation with 90% confidence interval; estimator for the Bayesian Information Criterion = MLR.
The best fitting model is shown in bold.

across various populations and settings to ensure the accurate measurement of PTSD in specific populations, this is especially important in chronic pain patients as PTSD measurements have tended to be overinclusive owing to the potential symptom overlap between PTSD and pain. In conclusion, the diagnostic consistency between the CAPS-5 and the PCL-5 was satisfactory, and the overall accuracy of the PCL-5 was good. Optimal results were achieved using the DSM-5 diagnostic algorithm rather than cut-off scores. Furthermore, the Danish PCL-5 showed excellent construct validity in both samples, favouring the seven-factor Hybrid model in both the sample of mixed traumatic exposure and the subsample of injury exposure. Furthermore, concurrent validity and discriminant validity were established. The results of the present study suggest that the PCL-5 is a valid assessment tool in the context of chronic pain and following traffic and work-related injuries.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethics statement

For the Pain Center data: the collected data are protected in accordance with the Act on the Processing of Personal Data (Act No. 429 of 31/05/2000) and the Law on the Status of Patients (Act No. 482 of 01/07/1998). As treatment was not affected by participation in the study, under Danish law, this study did not need ethics approval (Act on Research Ethics Review of Health Research Projects, October 2013, Section 14.2). For the rehabilitation data: the Regional Science Ethics Committee approved the study (J.nr. S-20130103). Informed consent: Written informed consent (electronic signature) was obtained from all patients from the Pain Center. For the rehabilitation data, written informed consent was obtained for the original study but was not needed for present study, as the data were anonymous at this point.

Data availability statement

The data used in the present study cannot be shared owing to the EU General Data Protection Regulation.

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