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ARTICLE

Post-traumatic stress disorder symptoms and pain intensity in persons with spinal cord injury

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Abstract

Study design Cross-sectional.

Objectives To examine the association between post-traumatic stress disorder (PTSD) symptoms and pain intensity, taking symptoms of anxiety and depression into account within persons with spinal cord injury (SCI).

Setting Persons with SCI, who visited a Dutch rehabilitation centre between 2005 and 2010, were invited to complete a survey.

Methods PTSD symptoms were measured with the Trauma Screening Questionnaire (TSQ), pain intensity with an 11-point Numerical Rating Scale (NRS), and symptoms of anxiety and depression with the Hospital Anxiety and Depression Scale (HADS). To determine associations between PTSD symptoms and pain intensity, linear regression analyses were performed. Confounding variables representing anxiety and depression were added to the final model.

Results In total, 175 participants (55.8% traumatic, 29.1% complete) were included (response rate of 31.7%). Of them, 11.4% had clinically relevant symptoms of probable PTSD (TSQ score ≥ 6) 69.8% experienced moderate to severe pain levels (NRS ≥ 4), 14.9% had symptoms of anxiety and 20.8% symptoms of depression (HADS scores ≥ 11). Levels of PTSD symptoms were strongly associated with symptoms of anxiety (0.54) and depression (0.49). Bivariate analyses showed a moderate significant association (0.30) between PTSD symptoms and pain intensity. This association became small (0.10) when anxiety and depression comorbidity were factored into the final regression model.

Conclusions No independent association between PTSD symptoms and pain intensity was shown when adjusted for anxiety and depression. Results of this study suggest the usefulness of screening for PTSD in persons with SCI (regardless of injury cause or type/level) who score high on symptoms of anxiety/depression.

Introduction

Pain is one of the most common complications after spinal cord injury (SCI), with at least three quarters of persons with SCI experiencing pain during rehabilitation [1, 2]. SCI-related pain includes nociceptive pain (including musculoskeletal/visceral/other nociceptive pain), neuropathic pain (including at-level/below-level/other neuropathic pain), and other pain [3]. Pain has a profound negative impact on quality of life and physical, and psychological functioning and well-being among persons with SCI [4, 5].

SCI-related pain and symptoms of post-traumatic stress disorder (PTSD) often mutually exist [6–9]. In veterans, the co-occurrence of pain and PTSD has been shown to be more common than the existence of either condition alone [8]. The direction of this association is unclear and possibly bi-directional. Veterans with PTSD who had no pain

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initially, were likely to develop pain over time [8]. And the other way around; sensations of pain can remind persons with chronic pain of the trauma and trigger PTSD symptoms [9]. The diagnosis of PTSD emphasises a causative event, with actual or threatened death, serious injury, or other threat to a person's physical integrity. The experience of the accident or attack that caused the SCI, or stay on an intensive care unit, may result in symptoms of PTSD [10]. PTSD prevalence rates, based on a combination of self-report and clinician-administered measures have varied from 7.1% up to 62% among persons with SCI [11–13]. These rates are much higher than the 2.1–5.4% in the general population [14]. These results indicate a potential for trauma-related approaches to treat pain.

SCI-related pain and PTSD are both related with mental health problems such as anxiety and depression [5, 7, 15]. Anxiety and depression without the occurrence of PTSD may influence SCI-related pain. The occurrence of PTSD without knowing or treating this, can undermine the (pharmaceutical) treatment of existing SCI-related pain, anxiety, or depression, and thus the aggravation of pain. However, previous studies among persons with SCI have not always analysed the possible role of mental health problems in the association between PTSD and pain [8]. Therefore, the association of PTSD with pain, adjusted for the symptoms anxiety and depression, will give more inside into this complex interrelation. It is important to know whether PTSD symptoms are still associated with pain once this association is adjusted for feelings of anxiety and depression. Further, gender, age, cause of the injury (traumatic or non-traumatic), completeness of the injury (complete or incomplete), level of the injury (paraplegia or tetraplegia), and time since injury may also influence this relationship [2, 4, 6, 16, 17].

Accordingly, the aims of this study are: (1) to test the association between symptoms of PTSD, anxiety and depression, and pain intensity and (2) to test whether the association between PTSD symptoms and pain intensity changes when adjusted for potential confounders, including anxiety and depression. We expect that this association still exists when taking symptoms of anxiety and depression into account.

Methods

Participants

A cross-sectional survey on pain was sent to persons with SCI who were treated in a Dutch rehabilitation centre, Reade, in Amsterdam between 2005 and 2010. Inclusion criteria were: (1) received rehabilitation treatment because of SCI, (2) minimum age of 18 years, and (3) sufficiently fluent in the Dutch language to complete a questionnaire. Participants received a postal survey although had the option to fill out a digital version. After 1 month, a reminder was sent. All participants provided written informed consent according to the Declaration of Helsinki. The study with the number P1138 was approved by the Slotervaart Hospital/Reade Institutional Review Board.

Measures

Sample characteristics

Demographic and injury-related information including gender, age, living situation, education level, having paid work and duration, cause, type, level, and AIS score of the SCI, were retrieved from the survey and medical files. Educational levels were merged into three levels: (1) 'Primary/Lower' including primary education and lower vocational education, (2) 'Intermediate' including advanced elementary education and intermediate vocational education, and (3) 'Higher/Academic' including higher general secondary education and higher vocational/academic education. Completeness and level of the injury were determined according to the International Standards for Neurological Classification of Spinal Cord Injury [18]. Complete SCI was defined as having no sensation and voluntary movement below the level of injury. Tetraplegia was defined as having a lesion at the cervical level.

Independent variable

PTSD symptoms were measured with the Trauma Screening Questionnaire (TSQ) [19]. The TSQ consists of ten statements about reactions in the past week. The first five statements are about re-experiencing (including: *'Acting or feeling as though the event was happening again'*) and the last five statements about arousal (including: *'Being jumpy or being startled at something unexpected'*). Each statement has the answering option 'yes' (1 point) or 'no' (0 points). Sum scores ≥ 6 points indicate 'probable PTSD'. The TSQ was identified as having great potential for routine use in primary care [20]. A Dutch study among victims of various civil traumas (e.g., assaults and traffic accidents) reported good sensitivity (0.94), positive (0.93), and negative (0.72) predictive power of the TSQ [21]. In our study, Cronbach's alpha for the TSQ was 0.83.

Dependent variable

Participants who answered 'yes' on a question about the presence of pain in the last week, were subsequently asked to rate their worst pain in the past week during the morning, afternoon, and evening. Scores were reported on an

11-point numerical rating scale (NRS) on which 0 represents having 'no pain at all' and 10 represents 'the most pain imaginable'. The mean of these three scores was used to indicate pain intensity. Mean NRS score ≥ 4 indicated 'moderate to severe pain' [22].

Controlling variables

Symptoms of anxiety and depression were measured with the Hospital Anxiety and Depression Scale (HADS). The HADS comprises of 14 statements about the past week, rated on a 4-point scale (score 0–3) in two subscales: anxiety (HADS-A) and depression (HADS-D). For each subscale, scores can range from 0 to 21. Higher scores indicate more symptoms of anxiety or depression. Scores of 8–10 indicate 'possible anxiety/depression', and scores ≥ 11 indicate 'probable anxiety/depression' [23]. The HADS has been shown to be valid and reliable in participants with SCI [24]. Missing HADS item scores were imputed only if at least five out of the seven items per subscale were completed, using the sample means. Cronbach's alpha of the HADS-A and HADS-D in our study were 0.88 and 0.84 respectively.

Statistical analysis

Statistical analyses were performed with SPSS, version 25 (IBM, Armonk NY). Descriptive statistics were used to analyse demographic and injury-related information. Differences in PTSD and pain intensity scores according to demographic and injury-related categories, were tested with ANOVA. Skewness of scale scores was considered acceptable between −1 and 1. Because of a skewed distribution, PTSD scores were log-transformed. (Skewness before: 1.231 and after: 0.476). Assumptions of linear regression, linearity, homoscedasticity, normality, and independence, were checked by inspecting residual plots, Q–Q plots of the continuous PTSD and the pain variables, and the autocorrelation function of the residuals (Durbin–Watson) respectively [25]. All assumptions were met.

The bivariate correlation between TSQ scale scores (0–10) on PTSD and NRS (1–10) scores on pain was calculated with linear regression analyses. Hereafter, possible confounders were checked by entering these one by one into the previous PTSD and pain intensity model. When the change in the regression coefficient was >10%, the variable was considered to be a confounder [26]. Based on literature, and in addition to anxiety and depression, these potential confounders included categorical data about: time since injury, cause of the injury (traumatic or non-traumatic), type of the injury (complete or incomplete), and AIS score [2, 4, 6, 16, 17]. Based on first impressions of our data, gender and age (categories) were also tested as confounders.

Finally, to analyse the influence of PTSD symptoms on pain intensity, controlled for confounding, a hierarchical regression analysis was performed. In terms of effect sizes, correlations ≥ 0.30 and ≥ 0.50, were indicated as 'medium' and 'large', respectively [27].

Results

Participant characteristics

Of the 551 invited persons with SCI, 186 (33.7%) completed and returned the questionnaires. Of the 365 non-responders, 41 had died, 42 had moved, 175 did not react, 81 declined participation, and 26 sent their informed consent without the questionnaire. Eleven responders did not meet the in- and exclusion criteria and were excluded, leaving 175 participants for the final analyses (31.7%). Table 1 shows the characteristics of all participants. Males (65.1%), persons who lived together (60.9%), were higher/academically educated (50.3%), and persons who did not have paid work (68.6%), covered more than half of the sample. Their mean (SD) age was 53.6 (14.1) years. The mean (SD) duration of the SCI was 13.8 (12.8) years. Traumatic (55.8%) and incomplete (70.9%) injuries occurred the most.

Outcomes on symptoms of PTSD, pain intensity, anxiety, and depression

Table 2 shows the mean (SD) scores of the main variables in this study. The TSQ was completed by 171 participants of whom 20 (11.7%) participants had probable PTSD. The overall mean (SD) number of TSQ statements answered with 'yes' was 2.1 (2.5). Mean pain, anxiety and depression scores within the group of participants with probable PTSD were much higher than these scores within the group that probably did not have PTSD. Table 1 shows that mean PTSD scores significantly differed for education level ($p = 0.015$), having paid work ($p = 0.046$), and time since injury ($p = 0.016$). Participants with a primary/lower education level had significantly more PTSD symptoms than participants with a different education level. The same accounted for participants without paid work compared to participants with paid work. Participants with more recent injuries (0–29 years) had significantly more PTSD symptoms compared to participants with injuries older than 29 years.

Three participants did not answer the questions about pain, 120 (69.8%) had moderate to severe pain levels (Table 2), 26 (15.1%) did not have pain at all, and another 26 (15.1%) had mild pain levels. The overall mean (SD) NRS pain intensity score was 5.6 (2.2). Mean scores for PTSD symptoms, anxiety and depression within the group

Table 1 Participant characteristics and mean scores for PTSD symptoms and pain intensity.

	All participants ($N = 175$)	PTSD scores		Pain intensity scores[a]	
	N (%)	Mean (SD)	*P* value	Mean (SD)	*P* value
Gender			0.407		0.925
Male	114 (65.1)	2.2 (2.5)		5.6 (2.1)	
Female	61 (34.9)	1.9 (2.5)		5.6 (2.2)	
Age			0.193		0.979
20–29 years	11 (6.3)	2.9 (3.3)		5.0 (2.1)	
30–39 years	23 (13.1)	2.8 (2.6)		6.1 (1.8)	
40–49 years	34 (19.4)	1.8 (2.5)		5.7 (2.3)	
50–59 years	48 (27.4)	2.0 (2.6)		5.5 (2.3)	
60–69 years	38 (21.7)	2.0 (2.2)		5.3 (2.0)	
70 years or older	21 (12.0)	1.9 (2.3)		6.2 (2.5)	
Living alone or together			0.123		0.130
Alone	72 (41.1)	2.5 (2.6)		5.9 (2.2)	
Together	103 (60.9)	1.9 (2.4)		5.3 (2.1)	
Educational level			0.015		0.000
Primary/Lower	26 (14.9)	2.9 (2.7)		6.7 (2.0)	
Intermediate	61 (34.9)	2.4 (2.7)		6.0 (2.0)	
Higher/Academic	88 (50.3)	1.7 (2.2)		5.0 (2.1)	
Paid work			0.046		0.034
Yes	55 (31.4)	1.6 (2.3)		5.0 (2.1)	
No	120 (68.6)	2.4 (2.5)		5.8 (2.2)	
Time since SCI (years)			0.016		0.546
0–9 years	91 (54.8)	2.5 (2.7)		5.7 (2.1)	
10–19 years	32 (19.3)	1.9 (2.4)		5.7 (2.2)	
20–29 years	17 (10.2)	2.8 (2.2)		5.1 (2.4)	
30–39 years	18 (10.8)	0.9 (2.0)		5.2 (2.2)	
40–49 years	5 (3.0)	0.0 (0.0)		5.5 (2.2)	
50–59 years	2 (1.2)	2.5 (0.7)		6.5 (2.6)	
60–69 years	1 (0.6)	1.0		–	
Cause SCI			0.569		0.932
Traumatic	96 (55.8)	2.0 (2.5)		5.6 (2.0)	
Non-traumatic	76 (44.2)	2.3 (2.5)		5.6 (2.4)	
Type of SCI			0.143		0.879
Complete	51 (29.1)	1.7 (2.0)		5.5 (2.2)	
Incomplete	124 (70.9)	2.3 (2.6)		5.6 (2.2)	
Level of SCI			0.885		0.878
Paraplegia	115 (65.7)	2.1 (2.5)		5.6 (2.1)	
Tetraplegia	60 (34.3)	2.2 (2.5)		5.6 (2.2)	
AIS score			0.130		0.644
A, complete	51 (29.1)	1.7 (2.0)		5.5 (2.2)	
B, sensory incomplete	15 (5.6)	2.9 (3.2)		5.6 (2.3)	
C, motor incomplete	24 (13.7)	1.6 (2.4)		5.1 (2.0)	
D, motor incomplete	75 (42.9)	2.3 (2.6)		5.6 (2.3)	
Unknown	10 (5.7)	3.2 (2.9)		6.2 (1.6)	

PTSD post-traumatic stress disorder, *SCI* spinal cord injury, *AIS* American Spinal Injury Association (ASIA) Impairment Scale.

[a]Average worst pain on three time points according to the Numerical rating scale (NRS) score between 1 and 10.

Table 2 Mean scores for all participants and participants with probable PTSD and higher pain levels.

	Mean scores (SD)[a]					
	All participants	PTSD symptoms		Pain		
		Probable PTSD ($n = 20$)	Probably no PTSD ($n = 151$)	Moderate to severe pain levels ($n = 120$)	Lower pain levels ($n = 26$)	No pain ($n = 26$)
PTSD symptoms (0–10)	2.1 (2.5)	7.4 (1.4)	1.4 (1.6)	2.6 (2.7)	1.0 (1.5)	1.0 (1.6)
Pain intensity (0–10)	5.6 (2.2)	7.4 (1.3)	5.3 (2.1)	6.3 (1.7)	2.4 (0.8)	N/A
Anxiety symptoms (0–21)	6.0 (4.4)	12.4 (4.0)	5.2 (3.8)	6.7 (4.5)	4.4 (3.9)	5.2 (4.3)
Depression symptoms (0–21)	6.4 (4.6)	11.5 (4.6)	5.8 (4.1)	7.2 (4.7)	4.5 (3.6)	4.7 (4.1)

Measures and cut-off scores: Probable PTSD—'yes' ≥ 6 items from the Trauma Screening Questionnaire (TSQ). Moderate to severe pain levels—Average worst pain on three time points according to the Numerical rating scale (NRS) score ≥ 4. Lower pain levels—Average worst pain on three time points according to the NRS score between 1 and 4. Anxiety and depression symptoms—Hospital Anxiety and Depression Scale (HADS).

PTSD post-traumatic stress disorder, *SCI* spinal cord injury, *AIS* American Spinal Injury Association (ASIA) Impairment scale.

[a]The differences in mean scores between PTSD and pain subgroups were all significant, $p < 0.02$.

of participants with moderate to severe pain levels ($n = 120$), were higher than these mean scores within the group of participants with lower pain levels ($n = 26$) or without pain ($n = 26$). Table 1 shows that mean pain intensity scores significantly ($p < 0.05$) differed for education level and having paid work. Participants with a higher education level, reported significantly lower mean NRS pain intensity scores compared to participants with intermediate or lower education levels. Participants with paid work also reported a significant lower mean pain intensity compared to participants without paid work.

The overall mean (SD) HADS anxiety score was 6.0 (4.4) (Table 2). Most (67.2%) participants did not have symptoms of possible or probable anxiety. The overall mean (SD) HADS depression score was 6.4 (4.6). Mean HADS scores were higher among the participants with symptoms of probable PTSD. Most (65.3%) of the participants also did not report symptoms of possible or probable depression. Yet, one-fifth of the participants scored in the probable depression category.

Associations between PTSD symptoms, pain intensity, anxiety, and depression

Analyses showed a moderate significant association ($\beta = 0.30$) between PTSD symptoms and pain intensity, as well as strong significant associations between PTSD symptoms and feelings of anxiety and depression ($\beta = 0.54$ and $\beta = 0.49$, respectively) (Table 3). Anxiety and depression, but none of the tested demographic and injury-related variables, were confounders of the associations between PTSD symptoms and pain. After adding feelings of anxiety and depression to the regression model, the total amount of explained variance doubled to 16.8%, although none of

Table 3 Bivariate associations between independent, dependent, and confounding variables.

	Pearson correlations ($N = 144$)		
	PTSD symptoms	Anxiety symptoms	Depression symptoms
Pain intensity	0.30[a]	0.37[a]	0.36[a]
PTSD symptoms	1	0.54[a]	0.49[a]
Anxiety symptoms		1	0.64[a]
Depression symptoms			1

Measures: PTSD symptoms—Trauma Screening Questionnaire (TSQ). Pain intensity—Average worst pain on three time points according to the Numerical rating scale (NRS). Anxiety and depression symptoms—Hospital Anxiety and Depression Scale (HADS).

PTSD post-traumatic stress disorder.

[a]Significant at $p < 0.001$.

Table 4 Hierarchical regression analysis with pain intensity as dependent variable.

Step	*N*	Variable	*β*	*P* value	95% CI	R^2
1	142	PTSD symptoms	0.30	0.000	0.53–1.75	8.8%
2	140	PTSD symptoms	0.10	0.276	−0.32–1.11	16.8%
		Anxiety symptoms	0.20	0.064	−0.01–0.20	
		Depression symptoms	0.18	0.081	−0.01–0.18	

Measures: Pain intensity—Average worst pain on three time points according to the Numerical rating scale (NRS). PTSD symptoms—Trauma Screening Questionnaire (TSQ). Anxiety and depression symptoms—Hospital Anxiety and Depression Scale (HADS). All demographic and injury-related variables were excluded since none caused a change in the regression coefficient >10%.

PTSD post-traumatic stress disorder, *SCI* spinal cord injury, *CI* confidence interval, R^2 explained variance.

these three variables showed a significant beta value (Table 4). When demographic and injury-related variables were added to the model as well, model statistics hardly changed, showing a positive difference of only 1.1% explained variance compared to the model with anxiety and depression alone, and none of the weak associations was significant.

Discussion

The present study examined the association between PTSD symptoms and pain intensity, taking symptoms of anxiety and depression into account. About one-tenth of the participants had probable PTSD. Most participants experienced moderate to severe pain levels. Regression models showed a moderate positive association between PTSD symptoms and pain intensity, accounting for a moderate correlation. Clearly, participants with probable PTSD symptoms experienced higher anxiety, depression and pain, compared to participants that probably had no PTSD symptoms. This finding is in accordance with previous literature [5, 7, 15]. Consequently, the association between PTSD symptoms and pain intensity became much weaker and insignificant after correction for the confounding effects of anxiety and depression.

The variation in pain intensity due to the probability of having symptoms of PTSD in our study, is comparable with effects found in previous studies. The strength of the moderate crude association between PTSD symptoms and pain intensity (0.30) is comparable with the slightly weaker correlation coefficient of 0.25 found in a another study [7], and the slightly stronger weighted correlation coefficient of 0.35 as found in a systematic review on PTSD in SCI [6]. While the tested potential confounders did not influence the correlation between pain intensity and PTSD, according to literature there might have been other factors that influenced the correlation between pain and anxiety and depression such as sleep and activity that were not measured in this study [28]. Our instrument of measuring pain differs to previous studies and the use of different pain instruments may have influenced the results they have found [7, 29]. To this end, comparison with other studies should not only take into account the inclusion of certain confounding variables, or the direction of the association, but also the instrument that represents pain.

Only educational level, having paid work, and time since injury were associated with significant differences in PTSD symptoms. However, none of the tested characteristics where confounders in the overall model. Based on the aetiology of PTSD, it was expected that the risk for PTSD symptoms would increase when participants experienced a trauma that caused the SCI [10]. However, the difference in occurrence of PTSD symptoms between traumatic and non-traumatic etiology was negligible in the current study. Since most studies reporting on PTSD occurrence, merely included traumatic SCIs, comparing the influence of the cause of the injury is not straightforward [11, 15–17].

Pain intensity was not significantly associated with gender, age, cause of the injury, completeness, level, and time since injury. Education level and having paid work did however make a difference in the mean pain intensity score. Other studies have confirmed the absence of an association between gender, completeness of SCI, and level of the injury with pain intensity and prevalence [2, 29, 30].

Clinical implications

The present results suggest that PTSD symptoms do not have an independent association with pain intensity. This might not be surprising given the inter-relatedness of the expression and aetiology of SCI-related PTSD or anxiety/depression symptoms [9]. Therefore, persons with a recently acquired SCI should be routinely screened for PTSD, anxiety, and depression [31]. Such a standard psychological screening should include well-validated instruments. According to the findings, it seems practical to start with investigating symptoms of anxiety and depression, since experience of anxiety and depression seems more common than probable PTSD. Additionally, to identify a possible need for psychological trauma-related interventions, persons with higher levels of anxiety and depression symptoms might be screened for PTSD as well, regardless of the aetiology of SCI. Effective, psychological trauma-related interventions preliminary incorporate Eye Movement Desensitization and Reprocessing or exposure (at best) [32]. Additionally, a recent study among persons with SCI, presented mixed preliminary results from mindfulness-

based interventions in the reduction of pain, anxiety, and depression [33]. These psychological trauma-related interventions might be effective in the treatment of SCI-related pain in persons with probable PTSD as well. Indeed, a comprehensive and individual treatment for SCI-related pain, may also incorporate the ideas persons have about their SCI and their pain coping strategies [2].

Limitations

The present study is subject to some limitations. First, the design does not allow to establish the direction of causality between PTSD symptoms and pain intensity. Second, only 16% of the variance of pain was explained in the final model. Therefore this association is influenced by other factors of which data were not available for the current study or are still unknown [28]. Third, the PTSD data only included information about arousal and re-experience, and did not include information about PTSD stressors (such as stay at an intensive care unit) or the experience of traumatic events before the experience of injury-related pain. The TSQ scores, like scores on other screening measures, are therefore not suitable for establishing diagnoses of PTSD among persons with SCI. Fourth, despite the fact that non-responder data were missing, the characteristics of the sample within this study are similar to results of a large multicenter register study in the Netherlands and therefore this sample seems representative for persons with SCI during rehabilitation in the Netherlands [34]. However, since most of the demographic- and injury-related characteristics were not associated with pain or PTSD, this representativeness should be interpreted with caution.

In conclusion, no independent association between PTSD symptoms and pain intensity was shown when adjusted for anxiety and depression. Nevertheless, the strong associations between symptoms of PTSD, anxiety and depression found in this study suggest the usefulness of screening for PTSD in persons with SCI (regardless of injury cause or type/level) who score high on symptoms of anxiety/depression.

Data availability

The datasets analysed during the current study are available from the corresponding author on reasonable request.

Author contributions HK performed the data analysis and drafted the paper. CCMvL provided feedback on the data analyses and the paper. DJK collected and prepared the data for the data analyses and provided feedback on the paper. JMSS designed the study, collected the data and provided feedback on the paper. MWMP provided feedback on the data analyses and the paper.

Compliance with ethical standards

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

Ethical approval We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

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