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The relationship between chronic whiplash-associated disorder and post-traumatic stress: attachment-anxiety may be a vulnerability factor

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***Background*:** In more than 90% of whiplash accidents a good explanation regarding the association between trauma mechanism, organic pathology, and persistent symptoms has failed to be provided.
***Objective*:** We predicted that the severity of chronic whiplash-associated disorder (WAD), measured as number of whiplash symptoms, pain duration, pain-related disability, and degree of somatisation would be associated with the number of post-traumatic stress disorder symptoms (PTSD). Secondly, we expected attachment-anxiety to be a vulnerability factor in relation to both PTSD and WAD.
***Design*:** Data were collected from 1,349 women and 360 men suffering from WAD from the Danish Society for Polio, Traffic, and Accident Victims. The PTSD symptoms were measured by the Harvard Trauma Questionnaire. All three core PTSD clusters were included: re-experiencing, avoidance, and hyperarousal. Attachment security was measured along the two dimensions, attachment-anxiety and attachment-avoidance, by the Revised Adult Attachment Scale.
***Results*:** PTSD symptoms were significantly related to the severity of WAD. In particular, the PTSD clusters of avoidance and hyperarousal were associated with the number of whiplash symptoms, disability, and somatisation. Attachment-anxiety was significantly related to PTSD symptoms and somatisation but not to pain and disability. A co-morbidity of 38.8% was found between the PTSD diagnosis and WAD, and about 20% of the sample could be characterised as securely attached.
***Conclusions*:** The PTSD clusters of avoidance and hyperarousal were significantly associated with severity of WAD. The study emphasises the importance of assessing PTSD symptomatology after whiplash injury. Furthermore, it highlights that attachment theory may facilitate the understanding of why some people are more prone to develop PTSD and WAD than others.

Keywords: *Whiplash*; *post-traumatic stress*; *attachment*; *pain*; *chronic*

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Whiplash is an acceleration and deceleration mechanism of energy transfer to the neck during a collision (Hendriks et al., 2005). Common symptoms after a whiplash injury are headache, neck pain, shoulder pain, fatigue, sleep disturbance, and memory problems (Jansen et al., 2008). When symptoms persist for more than 3 months the condition is usually characterised as chronic whiplash associated disorder (WAD). In more than 90% of cases no organic pathology can be found (Atherton et al., 2006). In addition, approximately 50% with WAD still report neck pain and disability 1 year after the injury (Caroll et al., 2009; Kamper, Rebbeck, Maher, McAuley, & Sterling, 2008; Williamson, Williams, Gates, & Lamb, 2008). The recovery process appears to follow a pattern of rapid improvement within the first 3 months, with only minor, if any, improvement thereafter (Kamper et al., 2008). There is an ongoing debate regarding prognostic factors;

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however, high initial pain and disability in addition to psychological factors such as post-traumatic stress and low self-efficacy have been confirmed as indicators of a poor prognosis. Socio-demographic and crash-related factors have been reported as having poor prognostic value (Caroll et al., 2009; Kamper et al., 2008).

Co-occurrence of WAD and PTSD

Research shows that pain and post-traumatic stress disorder (PTSD) or symptoms thereof frequently co-occur. In particular, when pain is secondary to motor vehicle accidents, up to 50% of individuals meet the diagnostic criteria for PTSD (Otis, Terence, & Kerns, 2003). Even years after the whiplash trauma, a high prevalence of PTSD is found. For example, Mayou and Bryant (2002) found that 17% of individuals still met the diagnostic criteria for PTSD 3 years after their whiplash injury. In addition, Stålnacke (2009) found that almost 38% still suffered from mild to severe post-traumatic stress symptoms 5 years after their whiplash injury. Furthermore, PTSD symptoms are significantly associated with whiplash-related symptoms, pain intensity, affective distress, and disability (Åhman & Stålnacke, 2008; Buitenhuis, Jong, Jaspers, & Groothoff, 2006; Ehlers, Mayou, & Bryant, 1998; Kongsted et al., 2008; Stålnacke, 2009). Unfortunately, few studies have included all PTSD symptom clusters and most are based on small samples. However, hyperarousal symptoms have been found important in relation to predicting chronic WAD (Buitenhuis et al., 2006). In alternative trauma populations, hyperarousal symptoms have also been associated with somatisation (Elklit & Christiansen, 2009).

Exploring the recovery process of PTSD symptoms after acute whiplash, Sterling, Hendrikz and Kenardy (2010) found three different recovery processes. One group of patients appeared to be resistant (40%) and another group with moderate PTSD symptoms at 1 month (43%), recovered to a mild symptomatic level after 3 months. A third chronic group (17%) presented with moderate to severe PTSD symptoms at 1 month that remained consistent at 12 months follow-up.

Mutual maintenance and shared vulnerability

It is indicated that WAD and PTSD are not necessarily distinct disorders, but may have a shared vulnerability that mutually maintains each other. Shared characteristics of the two disorders are hyperarousal symptoms, avoidance behaviour, emotional liability, and attention bias towards somatic cues (Asmundson, Coons, Taylor, & Katz, 2002; Sharp & Harvey, 2001). Within the mutual maintenance model (Sharp & Harvey, 2001) it is proposed that pain may be interpreted as a reminder of the whiplash trauma and as such triggers trauma memories that, in turn, trigger arousal and avoidance behaviour. In addition, high levels of arousal can have a negative impact on pain through muscle tension. In agreement with the mutual maintenance model, Sterling and Chadwick (2010) found that PTSD hyperarousal symptoms were causally related to pain, and that PTSD avoidance symptoms were related to disability. Also in support of the mutual maintenance model, Liedl et al. (2010) found that the level of pain at 3 and 12 months was predicted by PTSD re-experiencing and hyperarousal symptoms. Baseline pain predicted 3 months hyperarousal and 3 months pain predicted all PTSD symptom clusters. In particular, hyperarousal played a key role in the development of chronic pain over time.

Predictors of PTSD and vulnerability

Pre-trauma risk factors do generally have a weak effect on PTSD compared to the effects of trauma intensity and post-trauma factors (Brewin, Andrews, & Valentine, 2000). In particular, peritraumatic dissociation, peritraumatic emotions, perceived support, and perceived life threat are found to be the strongest predictors of PTSD (Ozer, Best, Lipsey, & Weiss, 2008). However, identification of possible vulnerability factors for PTSD may help identifying more specific cognitive mechanisms in PTSD. Three cognitive vulnerability factors have been described as relevant in the development of PTSD: negative cognitions about the self, the world, and self-blame for the trauma (Foa, Ehlers, Clark, Tolin, & Orsillo, 1999). Similarly, attachment insecurity is characterised by negative interpersonal cognitive-emotional schemas about self and others. Furthermore, it is possible that both PTSD and attachment-related cognitions can lead to threat appraisals of the pain and thereby symptom exacerbation (Elwood, Hahn, Olatunji, & Williams, 2009; Meredith, Ownsworth, & Strong, 2008).

According to Bowlby (1969/1997), attachment schemas are shaped from early interactions with caregivers and influence the way we perceive situations, regulate emotions, and relate to others. Attachment insecurity has been associated with PTSD and various other health conditions (for a review see Mikulincer & Shaver, 2007). Moreover, recently growing evidence has linked attachment insecurity to maladaptive adjustment to chronic pain conditions, which results in higher levels of pain, somatisation, and disability (for a review see Meredith et al., 2008). Longitudinal studies support the assumption that attachment representations are relatively stable traits (Hamilton, 2000; Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). However, severe negative life events, for instance physical or sexual abuse, can change attachment classification (Weinfield, Sroufe, & Egeland, 2000). Sanberg, Suess, and Heaton (2010) found that interpersonal traumas, in particular, have an impact on attachment-anxiety. In contrast, non-interpersonal

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trauma types such as motor vehicle accidents had no impact on attachment security.

Aims and hypotheses

Few studies have looked at the co-occurrence of PTSD and WAD when the disorder persists for more than 1 year. In addition, none of the extant literature has included all three PTSD symptom clusters. To our knowledge, there are no studies that have examined the role of attachment dimensions in relation to PTSD after whiplash trauma. We wanted to further validate and test the robustness of earlier findings linking PTSD with WAD and also include attachment insecurity as a possible vulnerability factor for developing PTSD and persistent WAD.

Hypotheses

First, we predicted that PTSD symptoms would be associated with severity of WAD, measured as number of whiplash symptoms, pain duration, pain-related disability, and degree of somatisation. Secondly, we expected that attachment-anxiety would be positively associated with both WAD and PTSD.

Methods

Participants

Data were collected from 1,349 women and 360 men suffering from chronic WAD. Participants were recruited from the Danish Society for Polio, Traffic, and Accident Victims. The society works for interests of the various member groups by addressing the government and by offering services to its members such as self-help groups, counselling, and so on. In most cases, membership of the society is obtained via a referral process through the Danish National Health Service and other sources. The present study was part of a larger study investigating the characteristics of those suffering from chronic WAD organised in the Danish Society for Polio, Traffic, and Accident Victims. All members of the whiplash group were contacted ($N = 2{,}320$). The response rate was 74%. Demographic information is reported in Table 1. There were no differences found between responders and non-responders on gender or age. The female to male ratio of respondents (approximately 4:1) closely matched the ratio of the complete patient group (Fink, Toft, Hansen, Ørnbøl, & Olesen, 2007). In addition, the findings are in line with findings from epidemiological studies, which have shown women to be at a higher risk of developing and maintaining whiplash-related symptoms compared to men (Harder, Veilleux, & Suissa, 1998).

Table 1. Demographic details

Variable	$N = 1{,}618$	%
Gender		
Male	341	21.1
Female	1,276	78.9
Mean age (SD)	42.9 (10.2)	
Mean years of education (SD)	13.0 (3.3)	
Marital status		
Not married	157	9.8
Living together	295	18.4
Married	971	60.7
Widower	22	1.4
Divorced	155	9.7
Children		
No	316	19.5
Yes	1,302	80.5
Employment affected		
No	215	14.3
Yes	378	25.2
Had to stop work	907	60.5
Pension	587	38.4
Number of whiplash		
One	1,388	86.1
Two	185	11.5
Three	36	2.4
Missing	9	.6
Other injuries		
Yes	795	50.1
No	792	49.9
Missing	31	1.9
Time since last whiplash injury		
Mean month (SD)	60.8 (65.0)	
Meeting criteria for PTSD	627	38.8
Attachment security (RAAS)		
Secure	297	18.4
Insecure	1,097	67.9
Non-categorised	224	13.7

Measures

Attachment security was measured with the Revised Adult Attachment Scale (RAAS; Collins & Read, 1990). The RAAS is an 18-item self-report scale on which participants rate statements about how they function and feel in a relationship with a partner, someone close, and people in general on a 5-point Likert scale (1 = not at all characteristic, 5 = very characteristic). The scale is two-dimensional: (1) items on closeness and dependency are merged into one dimension "close-dependency" ($\alpha = .62$) and (2) an anxious attachment dimension ($\alpha = .84$). Secure attachment is characterised by a combined score, above midpoint > 36 on the

close-dependency dimension and a score below midpoint <18 on the anxious dimension (Collins, 1995, unpublished reasearch note). A high score on the anxious attachment dimension is characterised by worry over the availability, responsiveness, and positive regard of others. A low score on the close-dependency dimension is characterised by discomfort with closeness and interdependence (Fraley & Waller, 1998).

The Trauma Symptom Checklist – Revised (TSC-R; Briere & Runtz, 1989; Krog & Duel, 2003) was used to measure somatisation. The scale consists of 23 items and measures a number of general distress symptoms on a 4-point Likert scale (1 = never, 4 = always). The internal consistencies as measured by Cronbach's alpha were excellent (somatisation $\alpha = .89$).

To measure the severity of PTSD symptomotology we used The Harvard Trauma Questionnaire part IV (HTQ; Mollica et al., 1992). The HTQ consists of 30 items on a 4-point Likert scale (1 = not at all, 4 = very often). Sixteen items relate to the three core clusters in PTSD in *DSM-IV*: avoidance (7 items, $\alpha = .77$), re-experiencing (4 items, $\alpha = .77$), and hypervigilance (5 items, $\alpha = .72$). Following the *DSM-IV*, a PTSD diagnosis was proposed if participants reported at least one re-experiencing symptom, three avoidance symptoms, and two hyperarousal symptoms. An item was deemed to be positively endorsed if scores were ≥ 3. The HTQ self-report measure of PTSD had 88% concordance with interview-based estimates of PTSD (Mollica et al., 1992). The internal consistency, measured by Cronbach's alpha was excellent (total $\alpha = .92$).

The degree of pain symptoms, sensory symptoms, and cognitive symptoms after whiplash trauma were assessed using The Whiplash Symptom Checklist (WSC; Elklit & Jones, 2007). Participants were asked to indicate on the WSC whether within the month prior to the study they had experienced any of the following symptoms: headache, neck pain, shoulder pain, weakness in arms, paraesthesia, vertigo, fatigue, nausea, tinnitus, auditory disturbances, reduced bite-function, visual disturbances, memory problems, problems reading and writing, or sleep disturbance. Cronbach's alpha was (total $\alpha = .77$).

The prevalence of painful episodes was measured on an 8-point verbal rating scale (0 = no painful episodes, 1 = very seldom, 2 = periodically, 3 = approximately 2 days per week, 4 = approximately 3.5 days per week, 5 = approximately 5 days per week, 6 = most of the time, 7 = all of the time).

Disability was measured as the level of interference caused from painful episodes on daily chores. The participants rated the disability level on a 4-point verbal rating scale (0 = no difficulty in performing daily tasks, 1 = difficulty in performing some tasks, 2 = difficulty in performing many tasks, 3 = difficulty in performing nearly all tasks).

Statistical analyses

The analyses were conducted in SPSS 17.0. For missing data replacement, multiple imputation was used as described by Rubin (1987). Missing data resulted in the exclusion of the case if more than 15% of the total answers were missing. Ninety-one cases were excluded from the sample. The excluded cases did not differ from the total sample on any of the demographic variables. The distribution of the data is presented as percentages, means, and standard deviations. To examine the relations between the continuous scales, a series of correlations were calculated. The hypotheses were further tested using a series of hierarchical multiple regressions. The regressions involved two steps for each dependent variable. In step 1, the demographic variables, (sex, age, years of education) and variables related to the injury (time since injury, numbers of whiplash, and whether other injuries were sustained or not) were entered. In step 2, the independent variables were entered.

Results

A high co-morbidity between chronic WAD and PTSD was found. According to the *DSM-IV* criteria, 38.8% of the participants fulfilled the criteria for a PTSD diagnosis (measured with HTQ). Only 18.8% of the participants were characterised as securely attached (measured with RAAS).

Correlation analysis

As shown in Table 2, all the correlations between the three PTSD symptom clusters (avoidance, hyperarousal, re-experiencing) and the outcome variables (whiplash symptoms, pain duration, disability, and somatisation) met criteria for statistical significance at $p < .01$. The weakest correlations were between re-experiencing and the outcome variables (whiplash symptoms, pain duration, disability, and somatisation). The correlations between the attachment dimensions and the PTSD symptoms also reached statistical significance at $p < .01$. Attachment-anxiety in particular correlated moderately with PTSD symptoms. Only small correlations were found between the attachment dimension "close-dependency" and PTSD symptoms. There were no statistically significant correlations between the attachment dimensions and pain duration and disability. However, a moderate correlation was found between attachment-anxiety and somatisation. For that reason the attachment dimensions were excluded from the following

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Table 2. Means, standard deviations, and correlations for primary study measures ($n = 1{,}618$)

	M	SD	1	2	3	4	5	6	7	8	9
1. PTSD symptoms	37.83	9.39									
2. Avoidance	15.17	4.99	.92**								
3. Hyperarousal	14.85	3.32	.84**	.65**							
4. Re-experiencing	7.81	2.71	.75**	.55**	.49**						
5. Attachment-anxiety	13.74	5.73	.36**	.36**	.31**	.22**					
6. Close-dependency	34.61	3.77	.11**	.10**	.11**	.07**	.21**				
7. Whiplash symptoms	10.23	3.01	.45**	.38**	.49**	.24**	.11**	.05*			
8. Pain duration	5.70	1.70	.29**	.26**	.32**	.15**	.00	.02	.48**		
9. Disability	2.05	.73	.39**	.38**	.36**	.21**	.04	−.00	.46**	.52**	
10. Somatisation	26.32	5.89	.63**	.55**	.69**	.34**	.26**	.10**	.63**	.45**	.45**

Note: *$p < .05$. **$p < .01$.
PTSD symptoms = total score of symptoms.
Disability = pain-related disability.

regressions on severity of WAD measured as whiplash symptoms, pain duration, disability, and somatisation.

Regression analyses with the PTSD symptom clusters as independent variables and severity of WAD as dependent variables

Four separate regressions were calculated, testing the association between the three PTSD clusters (avoidance, hyperarousal, re-experiencing) and the dependent variables (whiplash symptoms, pain duration, disability, and somatisation). The regression results are presented in Table 3.

The six background variables, as a block, contributed statistically significantly to the regression models, but explained only about 4–5% of the variance. Using a more conservative Bonferroni-type correction for alpha values ($.05/9 = .006$), only injuries, education, and age met criteria for significance at $p < .006$. Injuries had significant contribution in all equations except from in relation to somatisation. Education contributed negatively in relation to pain duration. Finally age had a positive relationship with somatisation. Surprisingly, using the Bonferroni-corrected alpha value, gender did not reach statistical significance in relation to any of the dependent variables.

In step 2 of the regressions, the PTSD clusters predicted 22.3% of the unique variance in relation to whiplash symptoms, 9% in relation to pain duration, 14.4% in relation to disability, and 45.7% in relation to somatisation. In particular, the clusters of avoidance and hyperarousal contributed a significant increment in all the equations except from in relation to pain duration. Here only hyperarousal met criteria for significance at $p < .006$. The PTSD cluster re-experiencing did not meet criteria for significance $p < .006$ in any of the regressions.

Regression analyses with the attachment dimensions as independent variables and PTSD symptoms as dependent variables

To test the role of attachment security on PTSD symptoms, a final regression was calculated entering the total score of the three PTSD clusters as the dependent variable and the attachment dimensions as independent variables. The regression results are presented in Table 4.

The contribution of the background variables in the first block was statistically significant explaining about 5% of the variance. Looking at the single predictors using a more conservative Bonferroni-type correction for alpha values ($.05/9 = .006$), gender, time since injury, and number of whiplash traumas did not met criteria for significance. Education correlated negatively with PTSD symptoms. In step 2 of the regression, the attachment dimensions explained 12.8% of the unique variance in relation to PTSD symptoms. Only attachment-anxiety met criteria for significance $p < .006$.

Discussion

In accordance with previous studies we found a high comorbidity between chronic WAD and PTSD. About 38% of the participants met the *DSM-IV* criteria for PTSD. This result is in agreement with studies that have reported between 30–50% of individuals meeting criteria for PTSD after motor vehicle accidents (Otis et al., 2003). However, when looking at whiplash injuries alone, as in the present study, other studies only found a PTSD rate of about 17% (Ehlers et al., 1998; Mayou & Bryant, 2002). Another recent study also found a high incidence

Table 3. Hierarchical multiple regressions with the PTSD symptom clusters

Predictors	Beta (final)	ΔR^2	Adj. R^2
Whiplash symptoms			
1. Gender	.408*		
Age	.013	.041***	
Education	−.016		
Time	.001		
Whiplash	.321*		
Injuries	.634***		
2. Avoidance	.077***		
Hyperarousal	.377***	.223***	.263***
Re-experiencing	−.065*		
Pain duration			
1. Gender	−.248*		
Age	.007	.043***	
Education years	−.055***		
Time	.000		
Whiplash	.159		
Other injuries	.301***		
2. Avoidance	.031**		
Hyperarousal	.138***	.090***	.127***
Re-experiencing	−.036		
Pain-related disability			
1. Gender	−.105*		
Age	.006**	.046***	
Education years	−.003		
Time	.000		
Whiplash	.056		
Other injuries	.150***		
2. Avoidance	.036***		
Hyperarousal	.046***	.144***	.185***
Re-experiencing	−.011		
Somatisation			
1. Gender	−.256		
Age	.047***	.045***	
Education years	−.075*		
Time	−.002		
Whiplash	.300		
Other injuries	.376		
2. Avoidance	.233***		
Hyperarousal	1.024***	.457***	.500***
Re-experiencing	−.137**		

Note: *$p < .05$. **$p < .01$. ***$p < .001$.
Time = time since last whiplash injury.
Whiplash = number of whiplash injuries.

Table 4. Hierarchical multiple regressions with the attachment dimensions

Predictors	Beta (final)	ΔR^2	Adj. R^2
PTSD symptoms			
1. Gender	.640		
Age	.090***	.052***	
Education years	−.328***		
Time	−.006		
Whiplash	1.332**		
Other injuries	2.124***		
2. Attachment-anxiety	.588***		
Close-dependency	.054	.128***	.175***

Note: **$p < .01$. ***$p < .001$.
PTSD symptoms = total score of symptoms.
Time = time since last whiplash injury.
Whiplash = number of whiplash injuries.

of PTSD symptoms; Stålnacke (2009) reported that almost 38% of individuals suffered from mild to severe stress symptoms 5 years after their injury. In contrast to our study they did not include the hyperarousal symptom scale and were therefore not able to determine how many of the participants actually meet the *DSM-IV* criteria for PTSD. The high incidence of PTSD in our study may be explained by the grouping characteristics. The participants represent a severely chronic group and may not be representative of the general WAD population. On the other hand, a high rate of PTSD in a severely chronic sample underlines the importance of the association between PTSD and chronic WAD.

The first hypothesis regarding the association between PTSD symptoms and severity of WAD, measured as whiplash symptoms, pain duration, pain-related disability, and somatisation was confirmed. The strongest associations were in relation to the hyperarousal symptom cluster also in alignment with Buitenhuis et al. (2006) and Liedl et al. (2010), who found hyperarousal to be the most important predictor of chronic pain and WAD symptoms. In agreement with Elklit and Christiansen (2009), we also found the strongest association between hyperarousal symptoms and somatisation. The results further validate that hyperarousal symptoms are important in relation to chronic WAD. Studies that use PTSD symptom scales not including hyperarousal symptoms possibly underestimate important characteristics of the disorder. The association between hyperarousal and chronic WAD may be due to anxiety sensitivity. It is hypothesised that anxiety sensitivity amplifies the intensity of emotional reactions and thereby increases the risk of developing and maintaining both PTSD and chronic pain (Asmundson & Stapleton, 2008).

The association between the avoidance symptom cluster and severity of WAD was also significant, although not as strong as was the case for the hyperarousal symptom cluster. Avoidance of activities that

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remind you of the accident possibly maintains chronic WAD similarly to the mechanisms proposed by the fear-avoidance model of chronic pain (Asmundson et al., 2002). According to the model, catastrophic thinking and fear of movement lead to maintenance of fear and to hypervigilance in relation to bodily sensations as in some phobias.

The second hypothesis, regarding the association between attachment-anxiety, PTSD, and chronic WAD was partly confirmed. The association between attachment-anxiety and PTSD symptoms is in agreement with previous studies done in other trauma populations (Declercq & Palmans, 2006; Diepernik, Leskela, Thuras, & Engdahl, 2002; Elwood & Williams, 2007; O'Conner & Elklit, 2008). The association might be explained by similar cognitive appraisals for both PTSD and attachment-anxiety. In agreement with Meredith et al. (2008), we found a moderate correlation between attachment-anxiety and somatisation. However, we did not find any evidence of a direct relationship between the attachment dimensions and pain duration. Furthermore, we found a high prevalence of insecure attachment. Only about 20% of the participants were classified as securely attached, a result far from the 60% normally found in the general population (Mickelson, Kessler, & Shaver, 1997). This might indicate that attachment insecurity is a vulnerability factor in the development of chronic WAD.

Limitations

This study has several limitations. One limitation relates to the population of the study, which is only representative of a segment of individuals with chronic WAD. Therefore, others should be cautious about the generalisation of the findings. The sample is a subset of severely chronic WAD patients who, on average, have had chronic WAD for about 5 years. Some sustained multiple whiplash injuries and the majority of the participants were classified as insecurely attached. Answers about causality call for longitudinal studies and further information about those who recover from the trauma. Although attachment orientations are considered relatively stable throughout the life course, it is possible that the whiplash trauma and the stress related to the persistent pain condition may have altered the participants' attachment orientations. Another limitation is that the study was part of a larger study with outcome measures not specifically chosen for the present study. A future study should consider using more standardised outcome measures for disability and pain intensity. More in-depth information in relation to other injuries sustained, treatment, and rehabilitation since the last whiplash injury would also strengthen the study. Unfortunately, we did not have this information available. However, we were able to control for some of those statistically (time since last injury, number of whiplash injuries, and whether other injuries were sustained).

Despite these limitations, a major strength of the study is the sample size and its unique focus on chronic WAD, PTSD, and attachment. The study describes important characteristics of those with severe chronic WAD. Finally, the inclusion of all three PTSD symptom clusters is a major strength, which makes it possible to estimate the prevalence of PTSD according to the *DSM-IV* diagnostic criteria.

Conclusion

Establishing a strong association between attachment insecurity, PTSD, and chronic WAD may be important in preventing the development of chronic WAD. Previous studies have identified early PTSD symptoms after whiplash trauma as one of the best predictors of chronic WAD (Williamson et al., 2008). Moreover, both PTSD symptoms and an insecure attachment have been found to complicate pain management (Meredith et al., 2008; Otis et al., 2003). To achieve successful outcomes in pain management it is also important to address PTSD symptoms (Otis et al., 2003), as the two conditions are reported as mutually maintaining each other (Sharp & Harvey, 2001).

Attachment-anxiety may serve as maintenance of chronic WAD through biased information processing, hypervigilance regarding threat, and the use of poor emotion regulation strategies leading to maladaptive coping (Meredith et al., 2008; Mikulincer & Shaver, 2007). However, it is too early to draw conclusions about treatment based on individual attachment orientations given the preliminary nature of these results. On the other hand, psychological interventions in pain management programs could profit by specifically targeting individuals with PTSD symptoms (particularly hyperarousal symptoms) in pain management programs.

Obviously, more longitudinal studies are needed to test the relationship between attachment-anxiety, PTSD, and the development of chronic WAD. Future studies should take special interest in possible moderators and mediators of the association between attachment insecurity, PTSD, and chronic WAD.

Conflict of interest and funding

There is no conflict of interest in the present study for any of the authors.

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