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Risk Factors for Developing Concurrent Posttraumatic Stress Injury After Work-Related Musculoskeletal Injury

A Case-Control Study

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Objective: This study aimed to study risk factors for developing concurrent posttraumatic stress injury (PTSI) among workers experiencing work-related musculoskeletal injury (MSI). **Methods:** A case-control study was conducted using workers' compensation data on injured workers undergoing rehabilitation programs for concurrent MSI and PTSI (cases) and MSI only (controls). A variety of measures known at the time of the compensable injury were entered into logistic regression models. **Results:** Of the 1948 workers included, 215 had concurrent MSI and PTSI. Concurrent MSI and PTSI were predicted by type of accident (adjusted odds ratio [OR], 25.8), experiencing fracture or dislocation fracture or dislocation (adjusted OR, 3.7), being public safety personnel (adjusted OR, 3.1), and lower level of education (adjusted OR, 1.9). **Conclusions:** Experiencing a concurrent PTSI diagnosis with MSI after work-related accident and injury appears related to occupation, type of accident, and educational background.

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Ethical Considerations and Disclosures: This study was approved by the Human Research Ethics Board of the University of Alberta (Pro00104421).

Funding Sources: The results reported herein correspond to specific aims of grant 20SPHIFR33-2 awarded to Douglas P. Gross from Alberta Labour and Immigration. This work was also supported by a research grant from the Workers' Compensation Board of Alberta. The Workers' Compensation Board of Alberta provided the data for this research.

Conflict of interest: Douglas P. Gross discloses research operating grants in the past 36 months from the Canadian Institutes for Health Research, Alberta Labour and Immigration, the Workers' Compensation Board of Alberta, WorkSafeBC, Canadian Hemophilia Society, and Medtronic. Sebastian Straube discloses financial relationships in the past 36 months with WorkSafeBC, the Canadian Board of Occupational Medicine, and the Workers' Compensation Board of Alberta.

Clinical Significance: Experiencing concurrent MSI and PTSI diagnoses following work-related accident and injury appears related to the nature of work conducted, type of accidents and injuries experienced, and educational background. Public Safety Personnel are at higher risk of concurrent MSI and PTSI. The risk factors identified in this study could inform targeted interventions in acute stages to help avoid development of PTSI.

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DOI: 10.1097/JOM.0000000000002621

Keywords: rehabilitation, posttraumatic stress disorder, public safety personnel, risk factors, compensation and redress

Workers experiencing traumatic musculoskeletal injury (MSI) are at risk of developing posttraumatic stress injury (PTSI).[1] The prevalence of posttraumatic stress after acute orthopedic trauma varies from study to study, but a recent meta-analysis of patients with acute orthopedic injuries reported a weighted pooled prevalence of diagnosed posttraumatic stress disorder of 26% (95% confidence interval [CI], 19.0%–35.9%).[2] Workers with concurrent MSI and PTSI are also more likely to experience delayed recovery, including being less likely to return to work.[3] Knowing risk factors for development of PTSI after MSI could help clinicians, employers, insurers, and other stakeholders intervene to prevent development of PTSI after injury, thus improving the prospect of clinical and return to work outcomes.

Previous research examining PTSI after MSI has identified a variety of salient risk factors related to the nature of the accident and injury, as well as clinical factors related to the acute injury.[1,4] A study of military personnel experiencing extremity long bone fracture found that lower extremity fracture, multiple fractures, and higher pain Visual Analog Scale (VAS) scores were associated with development of PTSI.[5] Other studies have identified that acute pain severity and associated psychological symptoms, such as catastrophizing, fear avoidance, low self-efficacy, and emotional problems, are also associated with development of PTSI symptoms.[6–10] These clinical characteristics are known to be influenced by physiological, social, and cultural factors.[11]

Posttraumatic stress injury symptoms and chronic pain from MSI share common psychological vulnerability factors, such as previous exposure to trauma or physical injury or preexisting mental health conditions, which increase the risk for complicated outcomes.[1] Symptoms of pain and psychological trauma have been conceptualized as "mutually maintaining" at physiological, affective, and behavioral levels.[12–14] This means that each PTSI and MSI can serve to maintain and exacerbate symptoms of the other. Without early identification of PTSI, individuals' symptoms are likely to worsen, and the subsequent co-occurring MSI and PTSI will become even more difficult to treat and rehabilitate. For these reasons, early identification of workers at risk of developing PTSI after work-related MSI is critically important. Improved knowledge of risk factors for developing PTSI will enhance our ability to detect workers in need of early PTSI assessment, intervention, and rehabilitation services and to tailor treatments to individual needs.

Many Canadian Workers' Compensation Boards (WCB) have implemented policies and care models to guide rehabilitation of workers with PTSI, which are accepted as compensable work-related injuries.[15–18] The WCB-Alberta implemented a PTSI care model in 2002 that includes psychological screening, cognitive-behavioral and exposure therapies, medical and psychiatric management, interdisciplinary rehabilitation, and worksite reintegration.[19] Accessing data consequent to this model, we studied injured workers undergoing rehabilitation in Alberta to identify risk factors for developing concurrent PTSI following work-related MSI.

METHODS

Design

A case-control study was conducted. Case-control research designs are observational studies that allow investigation of a phenomenon of interest, such as risk for developing PTSI, through comparing people with a condition (ie, cases) with those without the condition (ie, controls).[20] Because they are observational, case-control studies have some limitations for establishing definitive causal links. However, they are an epidemiological approach that can be used in situations where it is not ethically or practically possible to expose individuals to a factor of interest (in this situation, traumatic events) during a randomized controlled trial.[20] This research was approved by University of Alberta's Health Research Ethics Board. A waiver of informed consent was obtained because this study used archived historical data, and it was deemed to be either impractical or impossible to contact all workers to obtain consent.

Study Sample

We obtained information collected on all injured workers admitted to WCB-Alberta PTSI rehabilitation programs from across the province (n = 807) between January 1, 2017, and August 31, 2019. Of the 807 workers undergoing PTSI rehabilitation, 215 (26.6%) were also diagnosed with MSI as identified via file review and *International Classification of Diseases Ninth Revision*, diagnostic codes.[21] These 215 workers with both PTSI and MSI formed our case group. A control group was formed from a randomly selected group of 1733 workers from the broader population of workers with MSI admitted to other WCB-Alberta occupational rehabilitation programs during the same time frame, who did not subsequently develop PTSI over the study period.

PTSI Rehabilitation Programs

At the time of data collection, the WCB-Alberta model for PTSI rehabilitation recommended that injured workers with functional limitations in work duties due to trauma- or stressor-related disorders, anxiety-related or mood disorders, or other psychiatric conditions undergo a PTSI screening assessment.[19] A registered psychologist would interview the worker and administer relevant clinical tests to determine factors interfering with return to work that resulted from exposure to workplace trauma. If PTSI was suggested, workers were referred to varying levels of rehabilitation that have been described elsewhere.[3]

MSI Rehabilitation Programs

The WCB-Alberta rehabilitation programs for MSI also followed a continuum of care model.[22] Workers who had not recovered within 6 to 8 weeks after MSI were referred for multidisciplinary rehabilitation. Workers with MSI who also experienced or developed functional limitations due to trauma- or stressor-related disorders, anxiety-related or mood disorders, or other psychiatric conditions underwent a PTSI screening assessment as described previously and were transferred to a PTSI rehabilitation program.

Measures

Independent Variables

The data set included a variety of descriptive variables including demographic factors (eg, age, sex, and educational level), occupational factors (eg, National Occupational Classification code, whether the worker was public safety personnel [police, firefighter, paramedic/emergency medical technician, or corrections officer], employment and working status, and receipt of time loss benefits), health/injury factors (eg, type of accident, part of body injured, duration of injury, diagnosis, and number of previous claims), and self-ratings of pain intensity (100-point VAS), pain-related disability (Pain Disability Index),[23] and Health-Related Quality of Life (36-item Short-Form Health Survey [SF-36] domain scores).[24,25]

Outcome (Dependent) Variable

The outcome variable for this study was whether workers experienced concurrent MSI and PTSI (cases) or MSI only (controls) as determined by the rehabilitation program undertaken and confirmed by *International Classification of Diseases, Ninth Revision*, diagnostic codes and file review.

Data Analysis

We computed descriptive statistics for the workers in the data set, comparing workers undergoing PTSI rehabilitation (with and without MSI) with those undergoing rehabilitation programs for MSI only. We compared descriptive statistics of the 215 workers with concurrent MSI and PTSI with the 592 workers with PTSI only and 1733 workers with MSI only using appropriate statistics, including *t* tests and the χ^2 test. For our main objective, we used multivariable logistic regression[26] to identify significant risk factors for concurrent MSI and PTSI. We used a purposeful modeling strategy.[26] First, we used univariate logistic regression to examine each potential risk factor. The independent variables that were significant at *P* value of <0.10 were then entered into multivariable logistic regression models, and the variables that were not statistically significant at *P* value of <0.05 were removed. Next, the confounding effects of the removed variables on the retained variables were examined by observing for changes in regression coefficients of >20%. Relevant assumptions (eg, normality and collinearity) were tested.[27] The final models include all statistically significant variables at *P* value of <0.05. All analyses were done using IBM SPSS version 28 (Chicago, IL).

RESULTS

Characteristics of Workers Undergoing Rehabilitation

The case group was formed from the 215 workers undergoing rehabilitation for PTSI who had concurrent MSI (characteristics compared with those with PTSI only are shown in Table 1). The control group included 1733 workers with MSI only. Workers with concurrent MSI and PTSI were more likely to be public safety personnel (7.9% vs 1.7%, $P < 0.001$) who experienced traumatic injuries such as assault/violence (25.1% vs 1.8%, $P < 0.001$) or transport accidents (34.4% vs 6.0%, $P < 0.001$) rather than overexertion (3.3% vs 60.0%, $P < 0.001$). Workers with concurrent MSI and PTSI were markedly less likely to return to work after rehabilitation (32.1% vs 4.0% not fit to return to preaccident levels of work at discharge, $P < 0.001$).

Patient-Reported Measures

Scores on patient-reported measures are reported in Table 2. Compared with workers with MSI only, those with concurrent MSI and PTSI reported lower levels of pain intensity (46.6 vs 55.6 of 100, $P < 0.001$) and disability (42.0 vs 53.7 of 100 on the Pain Disability Index, $P < 0.001$). However, there were substantial missing data on the patient-reported measures, with 1243 workers (48.9%) not completing at least one of the VAS or PDI measures. Workers with missing data on the patient-reported measures were significantly more likely to have concurrent MSI and PTSI (77.2% vs 30.5%, $P < 0.001$), more likely to work in trades (39.9% vs 32.3%, $P < 0.001$), and less likely to be diagnosed with sprain/strain injury rather than fracture (28.3% vs 45.0%, $P < 0.001$). Because of the large amount of missing patient-reported data, separate multivariable analyses were conducted with and without the patient-reported measures.

Risk Factors for Developing Concurrent PTSI After MSI

Univariate, unadjusted odds ratios (OR) and 95% CI for developing PTSI in workers with MSI are shown in Table 3. Because of small numbers in some categories, some categorical variables were collapsed for logistic regression modeling. These variables included

TABLE 1. Characteristics of Injured Workers Admitted to WCB-Alberta PTSI Rehabilitation Programs Between the Years 2017 to 2019 (n = 2,540)

Variable	PTSI Only Mean ± SD or n (%)	MSK + PTSI Mean ± SD or n (%)	MSK Control Mean ± SD or n (%)	*P* Value
Demographic/administrative variables	n = 592	n = 215	n = 1,733	
Age, y	41.7 ± 11.4	42.6 ± 12.2	44.3 ± 12.4	0.69
Sex (% male)	311 (52.5)	132 (61.4)	1,006 (58.0)	<0.001
Public safety personnel (% yes)	252 (42.6)	17 (7.9)	29 (1.7)	<0.001
Type of public safety personnel				<0.001
Police/firefighter	65 (11.0)	3 (1.5)	15 (0.9)	
Paramedic/emergency medical technician	106 (17.9)	6 (2.8)	4 (0.2)	
Correction officer	81 (13.7)	8 (3.7)	10 (0.5)	
Not PSP	340 (57.4)	198 (92.1)	1,704 (98.3%)	
Type of accident				<0.001
Exposure to harm	261 (44.1)	27 (12.6)	4 (0.2)	
Transport accidents	62 (10.5)	74 (34.4)	104 (6.0)	
Assault/violence	155 (26.2)	54 (25.1)	32 (1.8)	
Overexertion and bodily reaction	85 (14.4)	7 (3.3)	1,040 (60.0)	
Contact with objects/equipment	14 (2.4)	26 (12.1)	182 (10.5)	
Falls	6 (1.0)	22 (10.2)	359 (20.7)	
Fire/explosion	6 (1.0)	4 (1.9)	0	
Other/unknown	3 (0.5)	1 (0.5)	12 (0.7)	
Diagnosis				<0.001
Sprain/strain	0	69 (32.1)	944 (54.5)	
Joint disorder	0	20 (9.3)	441 (25.4)	
Fracture	0	31 (14.4)	145 (8.4)	
Laceration/nerve damage	0	22 (10.7)	42 (2.5)	
Contusion	0	24 (11.2)	89 (5.1)	
Dislocation	0	0	26 (1.5)	
Other (including PTSI)	592 (100)	48 (22.3)	46 (2.7)	
Part of body				
Head injury	558 (94.3)	38 (17.7)	16 (0.9)	<0.001
Back and neck	0	74 (34.4)	685 (39.5)	
Extremity injury	0	79 (36.7)	919 (53.0)	
Multiple sites or unspecified	34 (5.7)	24 (11.2)	113 (6.5)	
Education				<0.001
Partial high school or less	22 (3.7)	20 (9.3)	163 (9.4)	
High school diploma	156 (26.4)	87 (40.5)	421 (24.3)	
Technical school	198 (33.4)	56 (26.0)	568 (32.8)	
Partial university/technical school	6 (1.0)	1 (0.5)	24 (1.4)	
University degree	51 (8.6)	14 (6.5)	110 (6.3)	
Not specified	159 (26.9)	37 (17.2)	447 (25.8)	
Occupational category				<0.001
Management	31 (5.2)	9 (4.2)	46 (2.7)	
Business, finance, and administration	47 (7.9)	6 (2.8)	100 (5.8%	
Natural and applied sciences and related	9 (1.54)	2 (0.9)	33 (1.9)	
Health	135 (22.8)	22 (10.2)	030 (11.7)	
Education, law, social and community services	176 (29.7)	24 (11.2)	91 (5.3)	
Art, culture, recreation and sport	2 (0.3)	2 (0.9)	14 (0.8)	
Sales and service occupations	40 (6.8)	37 (17.2)	315 (18.2)	
Trades	138 (23.3)	98 (45.6)	771 (44.5)	
Natural resources, agriculture, production	7 (1.2)	5 (2.3)	54 (3.1)	
Manufacturing and utilities	7 (1.2)	10 (4.7)	106 (6.1)	
Injury duration (mean days)	229.5 (558.3)	248.4 (730.0)	128.7 (579.3)	<0.001
Injury duration (median days)	84	94	56	
No. previous compensation claims	4.3 ± 5.2	3.2 ± 4.0	4.2 ± 5.3	0.10
Employed at admission? (% yes)	545 (92.1)	184 (85.6)	1,517 (87.5)	0.01
Working at admission? (% yes)	89 (15.0)	46 (21.4)	722 (41.7)	<0.001
Receiving wage replacement benefit (%yes)	459 (77.5)	148 (68.8)	922 (53.2)	<0.001
Rehabilitation program discharge outcome				
Return to work	70 (11.8)	44 (20.5)	863 (49.8)	<0.001
Fit for work	221 (37.3)	102 (47.4)	801 (46.2)	
Not fit for work/other outcome	301 (50.8)	69 (32.1)	69 (4.0)	

PSP, public safety personnel; PTSI, posttraumatic stress injury; WCB, Workers' Compensation Boards.

type of accident, diagnosis, part of body, education, and occupational category. The final categories used are shown in Table 3. A wide variety of occupational and injury-related factors were significantly associated with this outcome. Workers were at higher odds of developing PTSI if they were public safety personnel (OR, 5.05; 95% CI, 2.72–9.35); exposed to harm, accident, assault or fire as compared with overexertion injury (OR, 32.31; 95% CI, 22.76–45.85); diagnosed with severe MSI such as fracture or dislocation (OR, 3.53; 95%

TABLE 2. Baseline Scores on Patient-Reported Measures Completed by Injured Workers at Time of Admission to WCB-Alberta PTSI Rehabilitation Programs Between the Years 2017 to 2019

Variable	PTSI Only Mean ± SD or n (%)	MSK + PTSI Mean ± SD or n (%)	MSK Control Mean ± SD or n (%)	*P* Value
Patient-reported measures (n = 1,297)				
Pain VAS* (out of 100)	34.5 ± 27.7	46.6 ± 25.4	55.6 ± 23.5	<0.001
Pain Disability Index† (out of 100)	37.8 ± 16.4	42.0 ± 17.8	53.7 ± 19.7	<0.001
SF-36‡ domain scores				
Physical Functioning (n = 990)	33.4 ± 26.8	22.3 ± 21.6	37.0 ± 25.7	0.002
Role Physical (n = 917)	25.7 ± 23.5	23.0 ± 18.6	21.9 ± 22.0	0.57
Bodily Pain (n = 1,251)	66.9 ± 27.4	61.2 ± 29.1	29.2 ± 19.5	<0.001
General Health (n = 1,262)	34.0 ± 19.1	40.7 ± 19.1	64.1 ± 17.6	<0.001
Vitality (n = 1,283)	41.5 ± 14.0	40.3 ± 16.9	42.5 ± 19.5	0.72
Social Functioning (n = 1,274)	31.0 ± 21.4	34.7 ± 25.8	43.1 ± 23.9	<0.001
Role Emotional (n = 1,099)	33.3 ± 27.1	30.7 ± 27.3	40.3 ± 30.6	0.12
Mental Health (n = 1,279)	38.1 ± 14.6	45.0 ± 10.0	54.4 ± 19.8	<0.001

PTSI, posttraumatic stress injury; SF-36, 36-item Short-Form Health Survey; VAS, Visual Analog Scale.

*The pain VAS is a single-item patient-reported measure of pain intensity within the last 24 hours.

†The Pain Disability Index is a seven-item patient-report measure used to assess a respondents' perceived degree of pain-related impairment.

‡The SF-36 is a widely used quality of life tool that measures eight domains of physical heath, psychological health, and other aspects of well-being.

CI, 2.49–5.01) or other injury (including PTSI) (OR, 14.28; 95% CI, 8.90–22.90); or had a high school education or less (OR, 1.95; 95% CI, 1.47–2.59). Workers had lower odds of developing PTSI if they had more previous compensation claims (OR, 0.95; 95% CI, 0.92–0.98) or experienced injuries of the back/neck (OR, 0.23; 95% CI, 0.15–0.33) or extremities (OR, 0.18; 95% CI, 0.12–0.26) as compared with injuries of the head or multiple sites.

The adjusted ORs of variables in the final multivariable logistic regression model (shown in Table 3) indicated that workers were at higher odds of developing PTSI if they were public safety personnel (OR, 3.11; 95% CI, 1.22–7.91); exposed to harm, accident, assault or fire as compared with overexertion injury (OR, 25.84; 95% CI, 17.38–38.42); diagnosed with severe MSI such as fracture or dislocation (OR, 3.70; 95% CI, 2.33–5.89), or other injury (including PTSI) (OR, 4.69; 95% CI, 2.25–9.79); or had a high school education or less (OR, 1.94; 95% CI, 1.33–2.82). Number of previous workers' compensation claims was no longer significant in final models.

Patient-Reported Risk Factors for Developing Concurrent PTSI After MSI

When exploring patient-reported measures, both the pain VAS and Pain Disability Index were statistically significant univariate predictors ($P < 0.05$) along with several SF-36 domains (Physical Functioning,

TABLE 3. Logistic Regression Analysis Examining Risk Factors for PTSI in Workers Experiencing MSI (n = 1,948)

	Unadjusted Odds Ratio (95% CI)	*P*	Adjusted Odds Ratio (95% CI)	*P*
Demographic and occupational factors				
Age	0.99 (0.98–1.00)	0.06	1.00 (0.99–1.02)	0.72
Sex				
Male	1.0			
Female	0.97 (0.72–1.30)	0.83		
Public safety personnel (% yes)	5.05 (2.72–9.35)	<0.001	3.11 (1.22–7.91)	0.02
Type of accident				
Overexertion/falls/other	1.0		1.0	
Harm/accidents/assault/fire	32.31 (22.76–45.85)	<0.001	25.84 (17.38–38.42)	<0.001
Diagnosis				
Sprain/strain	1.0		1.0	
Fracture/dislocation/specific injury	3.53 (2.49–5.01)	<0.001	3.70 (2.33–5.89)	<0.001
Joint disorder	0.62 (0.37–1.03)	0.07	0.52 (0.29–0.93)	0.03
Other injury including PTSI	14.28 (8.90–22.90)	<0.001	4.69 (2.25–9.79)	<0.001
Part of body				
Head, multiple sites or unspecified	1.0		1.0	
Back and neck	0.23 (0.15–0.33)	<0.001	0.67 (0.35–1.26)	0.21
Arm and leg	0.18 (0.12–0.26)	<0.001	0.63 (0.34–1.17)	0.14
Education				
More than high school diploma	1.0		1.0	
High school or less	1.95 (1.47–2.59)	<0.001	1.94 (1.33–2.82)	<0.001
Occupational category				
Trades	1.0			
Other	0.96 (0.72–1.27)	0.76		
No. previous compensation claims	0.95 (0.92–0.98)	0.01	0.98 (0.93–1.02)	0.33

CI, confidence interval; MSI, musculoskeletal injury; PTSI, posttraumatic stress injury.

TABLE 4. Logistic Regression Analysis Examining Patient-Reported Risk Factors for PTSI in Workers Experiencing MSI

	Unadjusted Odds Ratio		Adjusted Odds Ratio	
	(95% CI)	*P*	(95% CI)	*P*
Patient-reported measures (n = 1,297)				
Pain VAS (out of 100)	0.99 (0.97–0.996)	0.01	0.99 (0.97–1.01)	0.30
Pain Disability Index (out of 100)	0.97 (0.96–0.99)	<0.001	0.99 (0.96–1.02)	0.47
SF-36 score				
Physical Functioning (n = 990)	0.97 (0.96–0.99)	0.001	1.00 (0.98–1.02)	0.73
Role Physical (n = 917)	1.00 (0.99–1.02)	0.76		
Bodily Pain (n = 1,251)	1.06 (1.05–1.08)	<0.001	1.08 (1.05–1.11)	<0.001
General Health (n = 1,262)	0.94 (0.92–0.95)	<0.001	0.95 (0.92–0.98)	<0.001
Vitality (n = 1,283)	0.99 (0.98–1.01)	0.45		
Social Functioning (n = 1,274)	0.99 (0.97–0.998)	0.02	0.96 (0.93–0.99)	0.004
Role Emotional (n = 1,099)	0.99 (0.98–1.00)	0.10		
Mental Health (n = 1,279)	0.98 (0.96–0.99)	0.001	1.00 (0.97–1.03)	0.996

CI, confidence interval; MSI, musculoskeletal injury; PTSI, posttraumatic stress injury; SF-36, 36-item Short-Form Health Survey; VAS, Visual Analog Scale.

Bodily Pain, General Health, Social Functioning, and Mental Health [Table 4]). Higher pain and disability levels were associated with lower odds of experiencing concurrent MSI and PTSI. Entering all significant patient-reported variables into a final model resulted in only the SF-36 Bodily Pain, General Health, and Social Functioning domains remaining predictive. Better Bodily Pain scores were associated with increased odds of concurrent MSI and PTSI (OR, 1.08; 95% CI, 1.05–1.11), whereas better General Health (OR, 0.95; 95% CI, 0.92–0.98) and Social Functioning (OR, 0.96; 95% CI, 0.93–0.99) were both associated with decreased odds of concurrent MSI and PTSI.

DISCUSSION

In this case-control study examining risk factors for developing concurrent MSI and PTSI, a variety of accident and injury-related variables were found influential. Public safety personnel are at higher odds of concurrent MSI and PTSI, likely because of the high-risk nature of the work conducted by police, firefighters, and paramedics and possibility of exposure to potentially traumatic events including transport accidents, fire, or assault. Workers exposed to these types of events in the workplace were at much higher odds (adjusted OR, 25.84) of developing concurrent MSI and PTSI. These types of workplace exposures are also more likely to lead to severe injury, such as fracture or dislocation. Diagnoses of severe MSI injuries such as fractures and dislocations also had higher odds of concurrent PTSI than sprain/strain injuries. In summary, the odds of experiencing concurrent MSI and PTSI diagnoses after work-related accident and injury appears highly dependent on the nature of work conducted and types of accidents and injuries workers experience.

Findings are consistent with previous research that has found that the nature of work and types of accidents and injuries workers experience are related to development of PTSI.[1,5] Our sample of workers with concurrent MSI and PTSI also reported worse general health and worse social functioning and had less attachment to the workplace (including being less likely to be working at admission and discharge from rehabilitation), which is consistent with previous research.[3,4] Our findings related to patient-reported pain intensity and disability were not consistent with previous research. We found that workers reporting higher pain and disability were at lower odds of developing concurrent MSI and PTSI. This is contrary to previous results that identified sustained high levels of pain intensity as predictive of developing posttraumatic stress symptoms.[8] These inconsistent findings could be due to the nature of our outcome, which was diagnosed PTSI rather than only experiencing symptoms of posttraumatic stress. It may also be due to the fact our patient-reported measures were not completed at the time of the accident but upon first admission for rehabilitation.

Our findings are consistent with suggestions that early clinical ratings of pain and disability or other patient-reported psychological or stress-related screening tools could help identify those most at risk of PTSI after MSI.[4,9,11] Further research is needed on preexisting mental health conditions or exposures to psychological trauma and risk of developing PTSI. Previous mental health problems may lower resilience in the face of MSI or other trauma as well as increase the risk of poor PTSI outcomes. Previous mental health issues may also be associated with lower education attainment,[28] worse general health,[29] and worse social functioning.[30,31] Previous research has highlighted that a diagnosis of posttraumatic stress disorder is associated with reduced educational performance across the lifespan,[28] but to our knowledge, ours is the first study to identify lower educational background as a risk factor for developing PTSI. To examine these issues in more depth, well-designed prospective studies are needed to follow cohorts of workers experiencing workplace injuries and accidents, ideally with biopsychosocial characteristics of the workers and workplaces measured before the injury event occurs.

Limitations

Limitations of the current study include reliance on archived data from the WCB-Alberta, which may limit generalizability, and large amounts of missing data on the patient-reported measures. Our study relied on accepted claims within one workers' compensation jurisdiction, and thus, our findings may reflect local policies or decision making. This may also have underestimated the frequency of workers experiencing posttraumatic stress symptoms who ultimately did not seek or receive treatment for PTSI within WCB-Alberta programs. Significant univariate associations were observed with a variety of clinical measures; however, because of the amount of missing data and the fact that these measures were not collected at time of initial injury, we did not include these variables in the final full model. There were also important differences between those with and without missing data, indicating the introduction of potential bias by including these variables in the models. Further prospective studies with more complete data sets are needed to reduce possible bias in the determination of associations and the predictive value of patient-reported factors.

REFERENCES

1. Kang KK, Ciminero ML, Parry JA, Mauffrey C. The psychological effects of musculoskeletal trauma. *J Am Acad Orthop Surg*. 2021;29:e322–e329.
2. Muscatelli S, Spurr H, O'Hara NN, O'Hara LM, Sprague SA, Slobogean GP. Prevalence of depression and posttraumatic stress disorder after acute orthopaedic trauma: a systematic review and meta-analysis. *J Orthop Trauma*. 2017;31:47–55.

3. Gross DP, Rachor GS, Yamamoto SS, et al. Characteristics and prognostic factors for return to work in public safety personnel with work-related posttraumatic stress injury undergoing rehabilitation. *J Occup Rehabil*. 2021;31:768–784.
4. Michaels AJ, Michaels CE, Moon CH, et al. Posttraumatic stress disorder after injury: impact on general health outcome and early risk assessment. *J Trauma*. 1999;47:460–466.
5. Lee CH, Choi CH, Yoon SY, Lee JK. Posttraumatic stress disorder associated with orthopaedic trauma: a study in patients with extremity fractures. *J Orthop Trauma* 2015;29:e198–e202.
6. Giummarra MJ, Casey SL, Devlin A, et al. Co-occurrence of posttraumatic stress symptoms, pain, and disability 12 months after traumatic injury. *Pain Rep*. 2017;2:e622.
7. Johnson L, Lodge C, Vollans S, Harwood PJ. Predictors of psychological distress following major trauma. *Injury*. 2019;50:1577–583.
8. Connor JP, Brier ZMF, Price P. The association between pain trajectories with posttraumatic stress disorder, depression, and disability during the acute posttrauma period. *Psychosom Med*. 2020;82:862–868.
9. Norman SB, Trim RS, Goldsmith AA, et al. Role of risk factors proximate to time of trauma in the course of PTSD and MDD symptoms following traumatic injury. *J Trauma Stress*. 2011;24:390–398.
10. Starr AJ, Smith WR, Frawley WH, et al. Symptoms of posttraumatic stress disorder after orthopaedic trauma. *J Bone Joint Surg Am*. 2004;86:1115–1121.
11. Lobo JJ, McLean SA, Tungate AS, et al. Polygenic risk scoring to assess genetic overlap and protective factors influencing posttraumatic stress, depression, and chronic pain after motor vehicle collision trauma. *Transl Psychiatry*. 2021;11:359.
12. Asmundson GJ, Coons MJ, Taylor S, Katz J. PTSD and the experience of pain: research and clinical implications of shared vulnerability and mutual maintenance models. *Can J Psychiatry*. 2002;47:930–937.
13. Sharp TJ, Harvey AG. Chronic pain and posttraumatic stress disorder: mutual maintenance? *Clin Psychol Rev*. 2001;21:857–877.
14. Turk DC. A diathesis-stress model of chronic pain and disability following traumatic injury. *Pain Res Manag*. 2002;7:9–19.
15. *Operational Policy Manual for Posttraumatic Stress Disorder in First Responders and Other Designated Workers*. Toronto, Ontario, Canada: Workers' Safety and Insurance Board; 2018. Available at: https://www.wsib.ca/en/operational-policy-manual/posttraumatic-stress-disorder-first-responders-and-other-designated. Accessed March 30, 2022.
16. Mental Health Disorders. WorkSafeBC; 2019. Available at: https://www.worksafebc.com/en/claims/report-workplace-injury-illness/types-of-claims/mental-health-disorders. Accessed March 30, 2022.
17. PTSD Presumption. Workers' Compensation Board of Manitoba; 2016. Available at: https://www.wcb.mb.ca/sites/default/files/resources/2990%20WCB%20PTSD%20Folder%20Inserts_Frequently%20Asked%20Questions-PTSD%20Presumption_0.pdf. Accessed March 30, 2022.
18. Psychological injuries from traumatic event(s) at work. Workers' Compensation Board of Alberta; 2021. Available at: https://www.wcb.ab.ca/assets/pdfs/employers/EFS_Psychological_injuries_from_traumatic_events_at_work.pdf. Accessed March 30, 2022.
19. Rose J. A model of care for managing traumatic psychological injury in a workers' compensation context. *J Trauma Stress*. 2006;19:315–326.
20. Rothman KJ. *Modern Epidemiology*. Philadelphia, PA: Wolters Kluwer; 2021.
21. American Medical Association. *Physician ICD-9-CM 2006: International Classification of Diseases, 9th Revision*. Chicago, IL: American Medical Association; 2005.
22. Stephens B, Gross DP. The influence of a continuum of care model on the rehabilitation of compensation claimants with soft tissue disorders. *Spine (Phila Pa 1976)*. 2007;32:2898–2904.
23. Chibnall JT, Tait RC. The Pain Disability Index: factor structure and normative data. *Arch Phys Med Rehabil*. 1994;75:1082–1086.
24. Ware JE, Gandek B. The SF-36 Health Survey: development and use in mental health research at the IQLOA project. *Int J Ment Health*. 1994;23:73.
25. Gross DP, Algarni FS, Niemelainen R. Reference values for the SF-36 in Canadian injured workers undergoing rehabilitation. *J Occup Rehabil*. 2015;25:116–126.
26. Hosmer DW, Lemeshow S, Sturdivant RX. *Applied Logistic Regression*. Wiley series in probability and statistics; *398*. Hoboken, NJ: Wiley; 2013.
27. Harrell FE Jr., Lee KL, Mark DB. Multivariable prognostic models: issues in developing models, evaluating assumptions and adequacy, and measuring and reducing errors. *Stat Med*. 1996;15:361–387.
28. Vilaplana-Perez A, Sidorchuk A, Perez-Vigil A, et al. Assessment of posttraumatic stress disorder and educational achievement in Sweden. *JAMA Netw Open*. 2020;3:e2028477.
29. Connell J, Brazier J, O'Cathain A, Lloyd-Jones M, Paisley S. Quality of life of people with mental health problems: a synthesis of qualitative research. *Health Qual Life Outcomes*. 2012;10:138.
30. Hirschfeld RM, Montgomery SA, Keller MB, et al. Social functioning in depression: a review. *J Clin Psychiatry* 2000;61:268–275.
31. Kennedy N, Foy K, Sherazi R, McDonough M, McKeon P. Long-term social functioning after depression treated by psychiatrists: a review. *Bipolar Disord*. 2007;9:25–37.

