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Predictors of Acute and Chronic PTSD in Road Trauma Survivors: Insights from a 12-Month Cohort Study

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Introduction: The present study reports the prevalence of acute post-traumatic stress disorder (PTSD) symptoms (2 months post-injury) and chronic PTSD symptoms (6 and 12 months post-injury) among road trauma survivors. We also examine baseline factors as potential predictors of acute and chronic PTSD symptoms post-injury.

Methods: This study followed a prospective cohort, enrolling 1480 survivors in Canada, between July 2018 and March 2020. PTSD symptoms were measured with the Post-traumatic Check-List Scale (PCL-S) at 2, 6, and 12 months post-injury. Baseline socio-demographic, psychological, medical, and injury-related factors were examined as predictors of acute and long-term PTSD symptoms using multivariable logistic regression.

Results: PTSD symptoms were reported by 241 of 1074 participants (22.4%) at 2 months, 167 of 935 (17.9%) at 6 months, and 141 of 872 (16.2%) at 12 months. Female sex, Asian ethnicity, more retrospectively reported pre-injury somatic symptoms, greater pre-injury psychological distress, and being a pedestrian (vs a driver) were consistently linked to higher odds of PTSD symptoms at 2 and 6 months. At 2 months, younger age, greater pre-injury pain catastrophizing, uncertain recovery expectations, and head or spine/back injuries were additional significant predictors, while by 6 months, having neck injury remained significant. By 12 months, chronic PTSD symptoms was associated with greater pre-injury pain catastrophizing, lower pre-injury health-related quality of life, and spine/back injury. Injury pain remained a predictor across all follow-ups.

Conclusion: PTSD symptom prevalence among survivors decreased between 2 and 6 months post-injury, but recovery rate slowed thereafter, with reduction between 6 and 12 months being much smaller than the earlier decrease. Furthermore, as some significant factors are modifiable, early interventions—such as effective pain management, psychological support, and coping strategy training—may help mitigate PTSD symptoms. Brief screening for psychological distress and pain catastrophizing could further support timely identification and referral of high-risk patients.

Keywords: road trauma injury, post-traumatic stress disorder, cohort study

Introduction

Post-traumatic stress disorder (PTSD) is a mental health disorder that may arise after a traumatic experience. PTSD symptoms include reexperiencing the traumatic event, avoidance and emotional numbing, and heightened arousal.[1] Globally, approximately 3.9% of people are estimated to experience PTSD at some point in their lives, with the rate rising to 5.6% among those who have encountered traumatic events.[2] Following road trauma (RT) injuries, PTSD prevalence varies, with a meta-analysis reporting rates from 6.3% to 58.3%.[3] While some individuals recover without intervention, others experience persistent PTSD symptoms lasting beyond 12 months. Recovery following RT injuries often prioritizes physical recovery while overlooking PTSD and other psychological consequences such as anxiety and depression. Poorer physical recovery, social withdrawal, impaired occupational functioning, and increased healthcare

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costs is associated with PTSD.[4–6] PTSD is also frequently associated with co-occurring psychiatric conditions, such as depression and anxiety.[7] People with PTSD following injury experience a significantly lower quality of life compared to those without PTSD.[4]

Road trauma associated PTSD has been linked to sociodemographic, psychological, and injury-related factors. An elevated risk has been linked to characteristics including being female,[6] having lower socioeconomic status,[8] and a prior history of mental health disorders.[9,10] Involvement in litigation, and previous motor vehicle accidents may also play a role.[9] Injury-related characteristics such as fractures, posttraumatic amnesia, pain severity, injury severity, and witnessing death[5,8] are also associated with higher PTSD risk. Kessler et al found that the socioeconomic and individual characteristics were mediated by peritraumatic symptoms, highlighting the role of early responses in PTSD development.[8] However, there is still no definitive consensus on the factors that predict PTSD after an injury.

Despite growing evidence, it remains unclear which RT survivors recover from acute PTSD and who will go on to develop chronic symptoms. While several longitudinal studies have examined PTSD following RT, most were conducted over a decade ago,[9,10] with only one recent example.[8] In contrast, recent research has largely relied on cross-sectional designs[6,11] conducted at varying timepoints, limiting the ability to draw conclusions about the trajectory and predictors of PTSD. Only a few studies have directly investigated changes in PTSD symptomatology over time,[10] thus the distinction between acute and chronic PTSD remains poorly understood, particularly in the context of RT injury. Moreover, most existing studies have primarily focused on patients with severe injuries,[12–15] despite evidence that minor injuries may result in lasting health effects.[16,17]

To fill these gaps, current study seeks to determine the prevalence of acute PTSD symptoms at 2 months and chronic PTSD symptoms at 6 and 12 months post-injury in RT survivors across all injury severities. In addition, it aims to study a variety of baseline factors as predictors of both acute and long-term PTSD symptoms following RT injury. Our findings may contribute to the early screening and identification of individuals at risk for developing PTSD symptoms after RT injury.

Methods

Participants and Procedure

This study prospectively recruited RT survivors from three emergency departments (EDs) in British Columbia (BC)—Vancouver General Hospital (Vancouver), Royal Columbian Hospital (New Westminster), and Kelowna General Hospital (Kelowna)—between July 2018 and March 2020, with participants being followed for 12 months after their injury. The study's methodology has been described in detail elsewhere.[18] Eligible participants were individuals aged 16 or older who sought emergency care within 24 hours of a collision involving at least one motorized vehicle. Children younger than 16 years old were excluded due to differing recovery trajectories following injuries. Those who were not residents of BC or who died within 30 days of the collision were excluded. This study examines data gathered at baseline and at 2, 6, and 12 months following injury, encompassing five types of road users: cyclists, pedestrians, motorcyclists, as well as drivers and passengers of motor vehicles. Figure 1 presents the flow diagram of enrolled participants, along with the numbers included in our study. Data were obtained through a combination of medical chart reviews and participant interviews. At baseline, research assistants conducted in-person interviews during emergency department visits or hospital stays, while a portion of interviews was carried out over the phone. Most interviews took place within one week of injury, over 98% were completed within two weeks, and all were finalized within 35 days, including participants with severe injuries who were initially unable to respond. Follow-up data were collected according to participant preference, using telephone calls, online surveys, self-administered paper questionnaires, or in-person interviews. For non-English-speaking participants, interviews were conducted in Cantonese, French, Korean, Mandarin, Punjabi, and Vietnamese by multilingual research assistants or with the help of a translator. All participants gave informed consent, either in writing or verbally. For minors aged 16–18, both parental or guardian approval and the participant's own assent were required. In cases where participants were unable to consent, such as those who were comatose, a designated caregiver provided proxy consent. The University of British Columbia's Research Ethics Board approved the verbal or written informed consent process (H18-00284). All procedures were conducted in accordance with the Declaration of Helsinki.

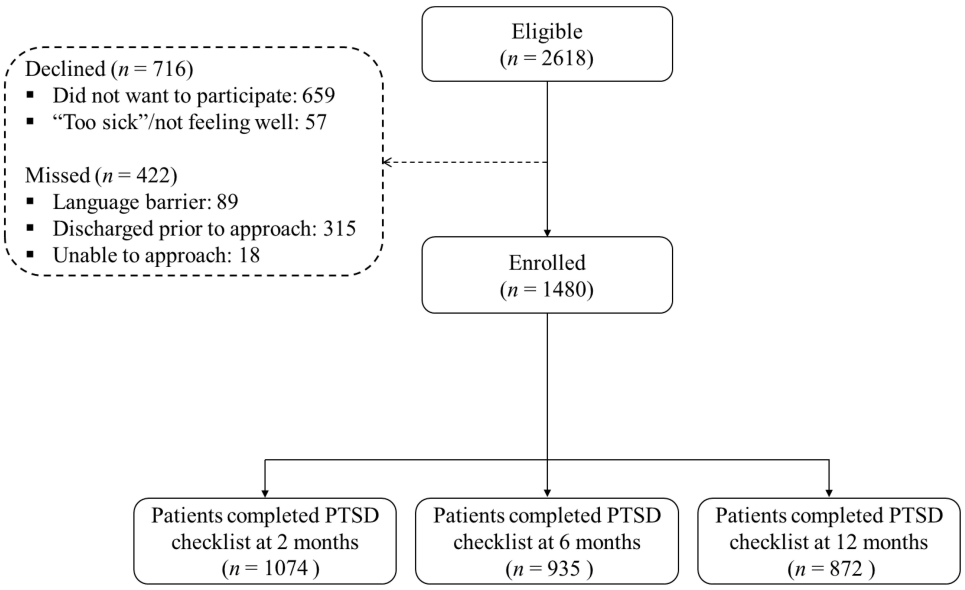

Figure 1 Recruitment flow diagram of the current study.

Variables and Measurements

The outcome of PTSD symptoms at 2, 6, and 12 months post-injury was evaluated using the Post-traumatic Checklist Scale (PCL-S),[19] a 17-item self-report measure based on DSM-IV criteria that evaluates PTSD symptoms experienced over the past month. The questions are framed around "stressful experiences from the past" and are categorized into three dimensions: reexperiencing, avoidance, and hyper-arousal. Responses are rated on a 5-point Likert scale, and the total score is obtained by summing the responses, with a maximum score of 85.

At baseline, various potential predictors of PTSD symptoms following RT injury were collected and categorized into four areas: sociodemographic, psychological, medical, and injury-related factors. Sociodemographic variables included age, gender, employment status, living situation, educational level, ethnicity, duration of residence in Canada, and any prior (pre-injury) use of alcohol or cannabis. Psychological variables encompassed recovery expectations (post-injury) and retrospectively reported pre-injury somatic symptoms, pain catastrophizing, psychological distress and health-related quality of life (HRQoL). Somatic symptoms were evaluated using the Patient Health Questionnaire-15 (PHQ-15; 2 weeks prior to the injury), with higher scores indicating more severe symptoms.[20] Pain catastrophizing was measured with the Pain Catastrophizing Scale, where higher scores indicated greater catastrophic thinking tendencies.[21] Psychological distress was assessed using the Patient Health Questionnaire-4 (PHQ-4; 2 weeks prior to the injury), higher scores pointed to more severe levels of depression and/or anxiety.[22,23] HRQoL was assessed using the Short Form 12 survey (SF-12; 4 weeks prior to the injury), where higher scores reflected better health.[24] Medical factors included number comorbidities, pre-injury complaints in the injured body area(s), and medication use. Pre-existing comorbidities reported by participants included conditions such as eye disease, arthritis, diabetes, respiratory disorders, heart disease, hypertension, stroke, epilepsy, kidney disease, psychiatric disorders, and any other conditions mentioned during the interview. Injury-related factors included the type of road user, Injury Severity Score (ISS),[25,26] pain resulting from the injury, and injury location. Immediate post-injury pain was reported during the baseline interview and assessed using a Visual Analog Scale (VAS).[27]

Statistical Analysis

Based on a systematic review, cutoff scores for the PCL-S have varied widely across studies, ranging from 32 to 50 depending on the population and study purpose.[28] Because the "optimal" cutoff score largely depends on its intended use, there is no single universally correct threshold. In this study, we used a high cutoff score of 50 to ensure that those screening positive actually have the disorder.[29] Therefore, participants with PCL-S scores ≥50 were classified as having

PTSD symptoms at each time point. For this study, "chronic PTSD symptoms" refer to meeting the PCL-S cut off at 6 or 12 months post-injury, regardless of earlier status. Differences in PCL-S subscale scores between participants with and without PTSD symptoms were assessed using Student's *t*-test. Baseline characteristics were summarized using descriptive statistics. Early predictors of acute PTSD symptoms (2 months post-injury) and chronic PTSD symptoms (6 and 12 months post-injury) were identified using logistic regression. Variables showing a significance level of $P < 0.2$ in the univariate analysis were selected for inclusion in the multivariable model. The final model was developed using backward elimination, retaining predictors that remained significant at $P < 0.05$. Results were reported as adjusted odds ratios (ORs) with 95% confidence intervals. Missing baseline covariate values were addressed through multiple imputation using the Markov Chain Monte Carlo approach, creating 10 separate imputed datasets. All baseline variables were considered in the imputation model, either as predictors or imputed variables. MCMC is a simulation-based approach that generates plausible values for missing data by iteratively sampling from the posterior distribution of the observed data. Data cleaning and statistical analyses were conducted using R version 4.0.5.

Results

Among the 1074 participants who completed a PTSD checklist at 2 months, 241 (22.4%) had PTSD symptoms. Among the 935 participants who completed a PTSD checklist at 6 months, 167 (17.9%) had PTSD symptoms. Among the 872 participants who completed a PTSD checklist at 12 months, 141 (16.2%) still met PTSD symptoms criteria. Table 1 summarizes the baseline characteristics of RT survivors across three follow-up periods (2, 6, and 12 months) based on PTSD status. At each follow-up, participants who developed PTSD symptoms tended to be younger, more often female, and had greater retrospectively reported pre-injury psychological distress, somatic symptoms, and pain catastrophizing relative to participants without PTSD symptoms. Post-injury pain severity at initial assessment remained consistently higher among participants with PTSD symptoms throughout the follow-up period.

Table 2 and Figure 2 delineate the adjusted ORs and 95% confidence intervals for factors linked to PTSD symptoms at 2, 6, and 12 months following injury, derived from multivariable logistic regression analyses. Female sex was associated with increased risk of PTSD symptoms; women were 52% more likely to have PTSD symptoms at 2 months (OR = 1.52, 95% CI: 1.09–2.12) and 83% more likely at 6 months (OR = 1.83, 95% CI: 1.24–2.70). Asian ethnicity emerged as a significant predictor at 2 months (OR = 1.76, 95% CI: 1.18–2.63) and 6 months (OR = 1.70, 95% CI: 1.07–2.70). Greater retrospectively reported pre-injury somatic symptoms, greater retrospectively reported pre-injury psychological distress and being a pedestrian (compared to a driver) consistently increased the odds of PTSD symptoms at both 2 and 6 months. At 2 months, younger age, greater retrospectively reported pre-injury pain catastrophizing, uncertain recovery expectations, and head or spine/back injuries were additional significant predictors, while by 6 months, having neck injury remained significant. By 12 months, chronic PTSD symptoms was associated with greater retrospectively reported pre-injury pain catastrophizing, lower retrospectively reported pre-injury HRQoL, and spine/back injury. Post-injury pain severity at initial assessment remained a robust predictor across all follow-ups; notably, each one-point increase in the injury pain score was linked to a 14% higher odds at 2 months (OR = 1.14, 95% CI: 1.06–1.23), a 20% higher odds at 6 months (OR = 1.20, 95% CI: 1.11–1.31), and a 17% higher odds at 12 months (OR = 1.17, 95% CI: 1.07–1.28).

Discussion

Trauma management has traditionally focused on physical injuries while psychological consequences of trauma are overlooked. PTSD is the most common psychopathological condition among RT survivors. In our study, 22.4%, 17.9%, and 16.2% of RT survivors had PCL scores suggestive of PTSD symptoms at 2, 6, and 12 months post-injury, respectively. The PTSD symptoms prevalence among RT survivors decreased by 4.5% between 2 and 6 months following injury, but the recovery rate slowed thereafter, with only a 1.7% reduction between 6 and 12 months. Our findings align with previous research. For instance, a study in France reported an 18% PTSD symptoms prevalence at 6 months post-injury using a PCL-S cut-off score of 44.[9] In Benin, a study applying a PCL-S cut-off score of 34 found a 26.4% prevalence at 12 months.[6] Similarly, research in southern Ethiopia documented a 15.4% PTSD symptoms prevalence at least one month post-injury using the PCL-S, though it did not differentiate between acute and chronic PTSD symptoms.[11] Our observed rates also align with those reported among RT survivors in Germany (18.4%),[5] the UK (29.1%),[30] southeastern Nigeria (26.7%),[31] and Serbia (36%).[32] Variations in PTSD symptoms

Table 1 Baseline Characteristics of Participant Based on PTSD Status

Characteristic	2 Months Follow Up			6 Months Follow Up			12 Months Follow Up		
	Total (n=1074, 100%)	PTSD Symptoms+ (n=241, 22.4%)	PTSD Symptoms − (n=833, 77.6%)	Total (n=935, 100%)	PTSD Symptoms + (n=167, 17.9%)	PTSD Symptoms − (n=768, 82.1%)	Total (n=872, 100%)	PTSD Symptoms + (n=141, 16.2%)	PTSD Symptoms − (n=731, 83.8%)
Sociodemographic factors									
Age	1074	39.7 (15.8)	44.2 (18.8)	935	40.7 (14.9)	43.6 (18.9)	872	41.5 (15.8)	43.7 (19.1)
Sex									
Male	555	102 (42.3)	453 (54.4)	482	63 (37.7)	419 (54.6)	436	57 (40.4)	379 (51.8)
Female	519	139 (57.7)	380 (45.6)	453	104 (62.3)	349 (45.4)	436	84 (59.6)	352 (48.2)
Employment status									
Employed	722	170 (71.4)	552 (67.9)	623	113 (70.2)	510 (67.7)	576	95 (69.3)	481 (67.1)
School	116	26 (10.9)	90 (11.1)	104	16 (9.9)	88 (11.7)	103	15 (10.9)	88 (12.3)
Retired/unemployed	213	42 (17.6)	129 (15.9)	187	32 (19.9)	155 (20.6)	175	27 (19.7)	148 (20.6)
Living situation									
Alone	246	59 (24.6)	187 (22.4)	218	42 (25.1)	176 (22.9)	200	39 (27.9)	161 (22.0)
With others	827	181 (75.4)	646 (77.6)	716	125 (74.9)	591 (77.1)	671	101 (72.1)	570 (78.0)
Education level									
Less than university	451	92 (38.3)	359 (43.1)	382	78 (46.7)	304 (39.6)	351	57 (40.4)	249 (40.3)
University	622	148 (61.7)	474 (56.9)	552	89 (53.3)	463 (60.4)	520	84 (59.6)	436 (59.7)
Ethnicity									
White	561	103 (42.9)	458 (55.0)	493	71 (42.5)	422 (55.0)	461	62 (44.0)	399 (54.6)
Asian	250	68 (28.3)	182 (21.8)	228	47 (28.1)	181 (23.6)	205	36 (25.5)	169 (23.1)
Others	262	69 (28.7)	193 (23.2)	213	49 (29.3)	164 (21.4)	206	43 (30.5)	163 (22.3)
Duration of residence in Canada									
> 10 years	923	193 (80.4)	730 (87.6)	803	138 (82.6)	665 (86.7)	753	120 (85.7)	633 (86.6)
≤10 years	150	47 (19.6)	103 (12.4)	131	29 (17.4)	102 (13.3)	118	20 (14.3)	98 (13.4)
Pre-existing alcohol use									
Yes	545	106 (57.9)	439 (66.8)	487	74 (54.0)	413 (68.5)	457	70 (64.8)	387 (67.0)
No	295	77 (42.1)	218 (33.2)	253	63 (46.0)	190 (31.5)	229	38 (35.2)	191 (33.0)
Pre-existing cannabis use									
Yes	209	47 (25.8)	162 (24.7)	177	35 (25.5)	142 (23.6)	161	26 (24.1)	135 (23.4)
No	630	135 (74.2)	495 (75.3)	562	102 (74.5)	460 (76.4)	524	82 (75.9)	442 (76.6)
Psychological and medical factors									
Somatic symptoms severity (PHQ-15)	1046	4.3 (4.6)	3.0 (3.1)	909	4.8 (4.9)	2.9 (3.1)	851	4.5 (4.5)	3.1 (3.2)
Pain catastrophizing	1057	9.8 (11.0)	6.3 (7.8)	914	10.4 (11.0)	6.5 (8.2)	854	10.6 (11.3)	6.7 (8.1)
Psychological distress (PHQ-4)	1073	1.88 (2.9)	0.9 (1.8)	934	2.13 (3.1)	0.9 (1.8)	871	1.7 (2.7)	1.0 (1.8)
Health-related quality of life (SF-12)	1069	104.0 (14.3)	107.4 (10.1)	927	102.8 (14.8)	107.6 (9.8)	864	103.0 (13.7)	107.6 (10.2)
Recovery expectations									
Less than 1 month	296	50 (27.3)	246 (37.5)	264	32 (23.4)	232 (38.6)	241	28 (25.9)	213 (36.9)
More than 1 month	193	37 (20.2)	156 (23.8)	172	40 (29.2)	132 (22.0)	163	24 (22.2)	139 (24.1)
No idea	350	96 (52.5)	254 (38.7)	302	65 (47.4)	237 (39.4)	281	56 (51.9)	225 (39.0)
Pre-injury comorbidities number	1074	0.98 (1.2)	1.0 (1.3)	935	1.1 (1.3)	1.0 (1.2)	872	1.2 (1.3)	1.0 (1.3)
Pre-injury body complaints									
Yes	240	60 (25.0)	180 (21.8)	215	45 (26.9)	170 (22.3)	205	36 (25.5)	169 (23.3)
No	825	180 (75.0)	645 (78.2)	714	122 (73.1)	592 (77.7)	661	105 (74.5)	556 (76.7)
Pre-injury medication use									
Yes	463	111 (46.1)	352 (42.3)	401	77 (46.1)	324 (42.2)	386	79 (56.0)	307 (42.0)
No	611	130 (53.9)	481 (57.7)	534	90 (53.9)	444 (57.8)	486	62 (44.0)	424 (58.0)

(*Continued*)

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Table 1 (Continued).

Characteristic	2 Months Follow Up			6 Months Follow Up			12 Months Follow Up		
	Total (n=1074, 100%)	PTSD Symptoms+ (n=241, 22.4%)	PTSD Symptoms − (n=833, 77.6%)	Total (n=935, 100%)	PTSD Symptoms + (n=167, 17.9%)	PTSD Symptoms − (n=768, 82.1%)	Total (n=872, 100%)	PTSD Symptoms + (n=141, 16.2%)	PTSD Symptoms − (n=731, 83.8%)
Injury-related factors									
Road user type									
Driver	499	104 (43.2)	395 (47.4)	431	76 (45.5)	355 (46.2)	399	67 (47.5)	332 (45.4)
Passenger	156	30 (12.4)	126 (15.1)	136	25 (15.0)	111 (14.5)	128	23 (16.3)	105 (14.4)
Motorcyclist	89	13 (5.4)	76 (9.1)	77	11 (6.6)	66 (8.6)	72	13 (9.2)	59 (8.1)
Pedestrian	194	63 (26.1)	131 (15.7)	165	37 (22.2)	128 (16.7)	159	30 (21.3)	129 (17.6)
Cyclist	136	31 (12.9)	105 (12.6)	126	18 (10.8)	108 (14.1)	114	8 (5.7)	106 (14.5)
ISS	1073	5.9 (6.8)	7.3 (9.8)	934	7.8 (9.0)	6.8 (9.3)	871	7.9 (9.0)	7.0 (9.5)
Injury pain (VAS)	835	6.2 (2.1)	5.0 (2.4)	734	6.4 (2.1)	4.9 (2.4)	683	6.2 (2.3)	5.0 (2.4)
Injury location									
Head (Yes)	413	109 (45.2)	304 (36.5)	343	65 (38.9)	278 (36.2)	324	62 (44.0)	262 (35.8)
Neck (Yes)	400	102 (42.3)	298 (35.8)	340	76 (45.5)	264 (34.4)	316	62 (44.0)	254 (34.7)
Torso (Yes)	407	95 (39.4)	312 (37.5)	366	77 (46.1)	289 (37.6)	356	60 (42.6)	296 (40.5)
Spine/back (Yes)	356	97 (40.2)	259 (31.1)	298	64 (38.3)	234 (30.5)	285	61 (43.3)	224 (30.6)
Upper extremity (Yes)	543	127 (52.7)	416 (49.9)	481	95 (56.9)	386 (50.3)	462	83 (58.9)	379 (51.8)
Lower extremity (Yes)	501	110 (45.6)	391 (46.9)	445	76 (45.5)	369 (48.0)	430	73 (51.8)	357 (48.8)

Note: Values are presented as mean (standard deviation) for continuous variables and frequency (percentage) for categorical variables.

Abbreviations: PTSD, post-traumatic stress disorder; PHQ-15, Patient Health Questionnaire-15; PHQ-4, Patient Health Questionnaire-4; SF-12, Short Form 12 survey; ISS, injury severity score; VAS, visual analog scale.

Table 2 Predictive Factors of PTSD Symptoms Assessed at 2, 6, and 12 months After the Injury

Characteristic	2 Months Follow Up (n=1074)				6 Months Follow Up (n=935)				12 Months Follow Up (n=872)			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Sociodemographic factors												
Age (each 10-year increase)	0.81 (0.81, 0.90)	0.027	0.81 (0.73, 0.90)	<0.001	0.81 (0.73, 0.90)	0.020	–	–	0.90 (0.81, 1.0)	0.163	–	–
Sex (Ref: Male)												
Female	1.83 (1.30, 2.58)	0.001	1.52 (1.09, 2.12)	0.013	2.36 (1.56, 3.56)	<0.001	1.83 (1.24, 2.70)	0.002	1.90 (1.21, 2.97)	0.005	–	–
Employment status (Ref: Employed)												
School	0.99 (0.58, 1.68)	0.981	–	–	0.65 (0.33, 1.27)	0.213	–	–	0.92 (0.44, 1.80)	0.827	–	–
Retired/unemployed	0.67 (0.42, 1.06)	0.092	–	–	0.63 (0.37, 1.07)	0.092	–	–	0.75 (0.42, 1.34)	0.337	–	–
Living situation (Ref: With others)												
Alone	1.19 (0.80, 1.77)	0.387	–	–	1.41 (0.90, 2.19)	0.129	–	–	1.74 (1.08, 2.81)	0.023	–	–
Education level (Ref: University)												
Less than university	0.79 (0.56, 1.12)	0.193	–	–	1.26 (0.85, 1.87)	0.234	–	–	1.11 (0.71, 1.72)	0.632	–	–
Ethnicity (Ref: White)												
Asian	1.87 (1.25, 2.80)	0.002	1.76 (1.18, 2.63)	0.005	1.71 (1.08, 2.72)	0.022	1.70 (1.07, 2.70)	0.024	1.45 (0.86, 2.45)	0.157	–	–
Others	1.46 (0.95, 2.22)	0.078	1.37 (0.92, 2.03)	0.150	1.56 (0.96, 2.56)	0.072	1.68 (1.07, 2.65)	0.023	1.41 (0.83, 2.41)	0.200	–	–
Duration of residence in Canada (Ref: > 10 years)												
≤10 years	1.76 (1.12, 2.76)	0.014	–	–	1.40 (0.82, 2.38)	0.210	–	–	0.93 (0.48, 1.80)	0.849	–	–
Pre-existing alcohol use (Ref: No)												
Yes	0.70 (0.49, 0.99)	0.049	–	–	0.54 (0.36, 0.81)	0.003	–	–	1.0 (0.63, 1.59)	0.987	–	–
Pre-existing cannabis use (Ref: No)												
Yes	1.07 (0.72, 1.58)	0.721	–	–	1.09 (0.69, 1.73)	0.693	–	–	0.98 (0.58, 1.64)	0.942	–	–
Psychological and medical factors												
Somatic symptoms (each score increase)	1.10 (1.05, 1.15)	<0.001	1.06 (1.01, 1.11)	0.019	1.11 (1.05, 1.17)	<0.001	1.10 (1.04, 1.16)	<0.001	1.12 (1.06, 1.19)	<0.001	–	–
Pain catastrophizing (each 10 score increase)	1.34 (1.10, 1.62)	<0.001	1.21 (1.10,1.48)	0.033	1.34 (1.10, 1.78)	<0.001	–	–	1.47 (1.10, 1.78)	<0.001	1.21 (1.10,1.62)	0.005
Psychological distress (each score increase)	1.14 (1.06, 1.22)	<0.001	1.10 (1.01, 1.19)	0.014	1.19 (1.09, 1.29)	<0.001	1.14 (1.05, 1.24)	<0.001	1.13 (1.03, 1.23)	0.008	–	–
HRQoL (each 10 score increase)	0.81 (0.66, 0.90)	0.010	–	–	0.73 (0.66, 0.90)	0.007	–	–	0.73 (0.59, 0.90)	0.002	0.73 (0.66, 0.90)	0.004
Recovery expectations (Ref: Less than 1 month)												
More than 1 month	1.15 (0.71, 1.86)	0.553	1.13 (0.67, 1.91)	0.627	2.17 (1.27, 3.72)	0.004	–	–	1.21 (0.66, 2.23)	0.523	–	–
No idea	1.85 (1.25, 2.74)	0.002	1.62 (1.07, 2.46)	0.023	2.02 (1.25, 3.26)	0.004	–	–	1.72 (1.04, 2.85)	0.035	–	–
Pre-injury comorbidities number	0.99 (0.87, 1.13)	0.974	–	–	0.96 (0.82, 1.13)	0.665	–	–	1.05 (0.89, 1.22)	0.530	–	–
Pre-injury body complaints (Ref: No)												
Yes	1.18 (0.78, 1.78)	0.430	–	–	1.13 (0.71, 1.82)	0.607	–	–	1.19 (0.71, 1.99)	0.493	–	–
Pre-injury medication use (Ref: No)												
Yes	1.18 (0.84, 1.65)	0.336	–	–	0.93 (0.63, 1.39)	0.746	–	–	1.70 (1.10, 2.65)	0.016	–	–
Injury-related factors												
Road user type (Ref: Driver)												
Cyclist	1.12 (0.70, 1.76)	0.622	1.40 (0.75, 2.54)	0.276	0.77 (0.40, 1.48)	0.438	1.75 (0.93, 3.33)	0.087	0.19 (0.06, 0.65)	0.008	–	–
Motorcyclist	0.65 (0.34, 1.21)	0.177	1.20 (0.60, 2.40)	0.591	0.53 (0.22, 1.31)	0.173	1.49 (0.68, 3.26)	0.310	1.04 (0.47, 2.27)	0.916	–	–
Passenger	0.90 (0.56, 1.42)	0.663	0.68 (0.41, 1.11)	0.124	1.08 (0.60, 1.94)	0.789	0.93 (0.54, 1.60)	0.809	1.23 (0.67, 2.27)	0.499	–	–
Pedestrian	1.82 (1.27, 2.64)	0.003	2.21 (1.45, 3.35)	<0.001	1.72 (1.03, 2.87)	0.037	1.83 (1.02, 3.06)	0.020	1.37 (0.77, 2.43)	0.271	–	–

(*Continued*)

Table 2 (Continued).

Characteristic	2 Months Follow Up (n=1074)				6 Months Follow Up (n=935)				12 Months Follow Up (n=872)			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
ISS (each 5 score increase)	0.90 (0.81, 1.05)	0.095	0.85 (0.77, 0.95)	0.035	1.10 (1.00, 1.21)	0.035			1.05 (0.90, 1.15)	0.362	–	–
Injury pain (each score increase)	1.22 (1.14, 1.32)	<0.001	1.14 (1.06, 1.23)	<0.001	1.34 (1.22, 1.47)	<0.001	1.20 (1.11, 1.31)	<0.001	1.22 (1.11, 1.34)	<0.001	1.17 (1.07, 1.28)	<0.001
Injury location												
Head (Ref: No)	1.43 (1.07, 1.92)	0.014	1.47 (1.06, 2.03)	0.020	1.12 (0.79, 1.58)	0.508	–	–	1.40 (0.97, 2.02)	0.068	–	–
Neck (Ref: No)	1.31 (0.98, 1.76)	0.064	–	–	1.59 (1.13, 2.23)	0.007	1.78 (1.19, 2.65)	0.004	1.47 (1.02, 2.12)	0.038	–	–
Torso (Ref: No)	1.08 (0.81, 1.45)	0.580	–	–	1.41 (1.01, 1.98)	0.043	–	–	1.08 (0.75, 1.59)	0.649	–	–
Spine/back (Ref: No)	1.49 (1.11, 2.01)	0.008	1.42 (1.01, 1.98)	0.038	1.41 (1.01, 2.01)	0.049	–	–	1.72 (1.19, 2.49)	0.004	1.52 (1.03, 2.23)	0.031
Upper extremity (Ref: No)	1.11 (0.83, 1.48)	0.451	–	–	1.30 (0.93, 1.83)	0.121	–	–	1.32 (0.92, 1.91)	0.127	–	–
Lower extremity (Ref: No)	0.94 (0.71, 1.26)	0.723	–	–	0.90 (0.64, 1.26)	0.554	–	–	1.12 (0.78, 1.61)	0.523	–	–

Note: –, not selected.

Abbreviations: OR, odds ration; CI, confidence interval; Ref, reference group; PTSD, post-traumatic stress disorder; PHQ-15, Patient Health Questionnaire-15; PHQ-4, Patient Health Questionnaire-4; HRQoL, Health-related quality of life; ISS, injury severity score; VAS, visual analog scale.

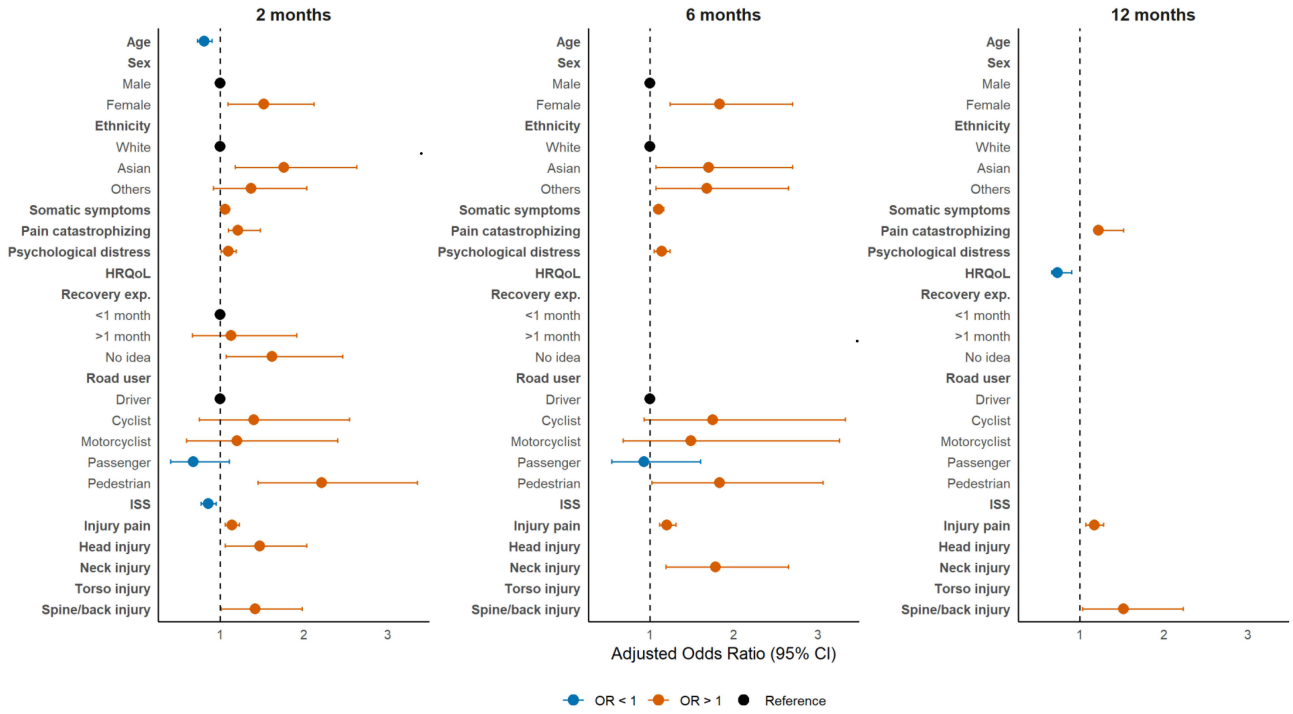

Figure 2 Adjusted odds ratios and 95% confidence intervals (CIs) for select factors at each time point from logistic regression models. Variables shown in bold represent the main variables, and those in non-bold text represent their categories.

prevalence across these studies likely stem from differences in cultural and socioeconomic contexts, sample sizes, assessment tools, thresholds for PTSD diagnosis, and evaluation timing. A 2018 meta-analysis also revealed a wide variability in PTSD symptoms prevalence among RT survivors, ranging from 6.3% to 58.3%.[3] A multicenter survey across 24 countries found a negative association between PTSD and vulnerability in general population. The study found that PTSD prevalence was highest in Canada, the Netherlands, and Australia, whereas the lowest rates were observed in Nigeria, China, and Romania.[33]

The study's second goal was to explore which participant characteristics predict the likelihood of experiencing acute and chronic PTSD symptoms following RT injuries. Characteristics that placed participants at risk of acute PTSD symptoms at 2 months post-injury were younger age, female sex, Asian ethnicity, greater retrospectively reported pre-injury somatic symptoms, pain catastrophizing, and psychological distress, uncertain post-injury recovery expectations, being a pedestrian, greater ISS, higher injury pain, and head or spine/back injuries. Characteristics that placed participants at risk of chronic PTSD symptoms at 6 or 12 months post-injury included female sex, non-White ethnicity, greater retrospectively reported pre-injury somatic symptoms, pain catastrophizing, and psychological distress, lower pre-injury HRQoL, being a pedestrian, higher injury pain, and injuries to the neck or spine/back.

The findings of this study align with prior research, which similarly indicated an elevated risk of both acute and chronic PTSD symptoms following RT injuries[8–10] or mixed traumatic events[34,35] among female patients. This heightened risk could be explained by the tendency of females to report lower overall satisfaction with their health[36] and experience greater fear and helplessness.[31,37,38] Younger patients in current study had a higher risk of acute PTSD symptoms, which aligns with a study by Brewin et al, indicating that younger age is a risk factor for PTSD symptoms, potentially due to differences in cognitive processing, social support, and coping strategies.[39] In contrast, some previous research found no significant relationship between age and acute PTSD symptoms.[8,10] The association between a history of psychological disorders and both acute and chronic PTSD symptoms has been extensively documented in the literature.[9,10,40,41] Pain catastrophizing is thought to increase the likelihood of developing PTSD symptoms following injury, as individuals who catastrophize pain often exaggerate pain-related fear, feel helpless in managing it, and ruminate on their discomfort. Consistent with previous research,[42] our results supported this hypothesis. Chossegros et al found that pain intensity six months after a RT injury was strongly associated with the development of chronic PTSD symptoms.[9] This aligns with our findings, which indicate that injury-related pain at baseline

is linked to both acute and chronic PTSD symptoms. Patients with severe pain may be more likely to appraise their situation negatively, potentially increasing the risk of PTSD symptoms. Similarly, an American study also highlighted the relationship between PTSD symptoms and pain intensity.[43] Finally, we observed a higher risk of PTSD symptoms among pedestrians compared to drivers, whereas earlier studies did not find a significant difference in PTSD symptoms risk between these groups.[9,11,44] One possible explanation for this increased risk is that pedestrians may experience the trauma as more sudden and uncontrollable, leading to heightened feelings of helplessness and fear, which are key factors in PTSD development.[45]

These results are encouraging, as they suggest it may be possible to pinpoint RT survivors at risk of developing acute or chronic PTSD symptoms upon hospital based on specific risk factors, some of which may be addressed by interventions. Our results highlight the importance of recognizing survivors with poor psychological health after injury as a high-risk group for PTSD symptoms, emphasizing the need for tailored rehabilitation strategies. Additionally, females, younger patients and individuals of Asian ethnicity may particularly benefit from early psychological therapy to mitigate the risk of acute PTSD symptoms. The elevated risk among Asian participants should be interpreted cautiously. In BC's multicultural context, factors such as language of interview and acculturation may have influenced the findings. Cultural stigma toward mental health, coping styles, help-seeking behaviors, and levels of social support across ethnic groups could also contribute to the disparities observed in PTSD risk. Moreover, it is important to avoid overgeneralizing "Asian" as a single category, since the Asian population in BC is highly diverse. Although our sample size limited subgroup analyses, future studies should consider disaggregating by ethnic subgroups (eg, East vs South Asian) to better understand potential cultural and contextual factors driving these associations. This underscores the importance of culturally sensitive screening and intervention approaches when designing hospital-based programs. Patients with pre-existing psychological distress, pain catastrophizing, multiple somatic complaints or low HRQoL may also require post-injury psychological support to improve recovery outcomes. To translate these findings into practice, hospitals could implement coordinated triage systems that include routine PTSD risk screening in the emergency department, followed by targeted early psychological interventions for high-risk groups. While the negative impact of traumatic brain injury on recovery is well established, our findings suggest that other injury types, such as spine injury, is also linked to worse consequences and may necessitate specialized programs.

A major advantage of this study is its longitudinal design, tracking participants over 12 months, along with the application of well-validated measurement instruments. Furthermore, to improve the applicability of our findings, no exclusions were made based on injury severity, type of road user, or language. Nonetheless, this study is subject to several limitations. First, our study used PCL-S to identify PTSD, without clinical diagnosis by a psychiatrist. Second, the patient characteristics collected in our study were not comprehensive. Future studies should consider additional factors that were not collected in our study, such as social support, peritraumatic dissociation, and perceived threat to life—particularly those identified as significant predictors of PTSD outcomes in meta-analyses.[46] Third, despite conducting baseline interviews within a week of the injury for most participants, retrospectively self-reported pre-injury HRQoL, somatic symptoms, and psychological distress may still have been affected by recall bias. In particular, participants experiencing acute PTSD symptoms could overestimate pre-injury distress due to mood-congruent recall. Fourth, selection bias may have arisen because older individuals and those experiencing "too much pain" might have been less likely to participate. Additionally, Moreover, survivors who either did not visit the hospital or were rapidly discharged from the ED may have been missed. Fifth, since patients with severe injuries are more likely to develop PTSD and less likely to participate in our study, the prevalence of PTSD in our cohort may be under-estimated. However, we acknowledge that the prevalence of PTSD in our sample could be either overestimated or under-estimated due to the subjective nature of its evaluation. Finally, our study recruitment continued into the onset of the COVID-19 pandemic, and we followed all patients for 12 months. Therefore, it is possible that baseline measures of mental health indicators, as well as PTSD outcomes, were influenced by pandemic-related stressors.

Conclusions

This prospective study highlights the high prevalence of PTSD symptoms in our sample during 12-months following RT injury. The PTSD symptoms prevalence among RT survivors decreased between 2 and 6 months post-injury, but the recovery rate slowed thereafter, with the reduction between 6 and 12 months being much smaller than the earlier decrease. Our findings confirm several key predictive factors for acute PTSD symptoms at 2 months, such as younger age, female gender,

retrospectively reported pre-injury somatic symptoms, pain catastrophizing, and psychological distress, ISS, and injury-related pain. At 6 months, chronic PTSD symptoms remained significantly associated with female gender, retrospectively reported pre-injury somatic symptoms, psychological distress, and injury pain. By 12 months, chronic PTSD symptoms was linked to greater pre-injury pain catastrophizing, lower pre-injury HRQoL, higher injury-related pain, and spine/back injury. These findings may help clinicians identify patients at risk of developing acute or chronic PTSD, enabling personalized care plans. Because some identified factors are modifiable, integrating early, practical interventions into post-injury care may help reduce PTSD symptoms and improve long-term recovery outcomes following RT injury. For example, emergency department protocols could include brief screening for pain catastrophizing and psychological distress using validated tools such as the PCS and PHQ-4, with referral pathways for high-risk patients. In addition, routine pain management, timely psychological support, and structured coping skills training may further mitigate PTSD symptoms.

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Disclosure

The authors report no conflicts of interest in this work.

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