EJP
European Journal of Pain

ORIGINAL ARTICLE

A population-based, incidence cohort study of mid-back pain after traffic collisions: Factors associated with global recovery

M.S. Johansson[1], E. Boyle[1,2], J. Hartvigsen[1,3], M. Jensen Stochkendahl[3], L. Carroll[4], J.D. Cassidy[1,2,5]

1 Department of Sports Science and Clinical Biomechanics, Faculty of Health, University of Southern Denmark, Odense, Denmark
2 Division of Epidemiology, Dalla Lana School of Public Health, University of Toronto, ON, Canada
3 Nordic Institute of Chiropractic and Clinical Biomechanics, Odense, Denmark
4 School of Public Health and the Alberta Centre for Injury Control and Research, University of Alberta, Edmonton, AB, Canada
5 Division of Health Care and Outcomes Research, Toronto Western Research Institute, University Health Network, Toronto, ON, Canada

Correspondence
Melker S. Johansson
E-mail: melker.johansson@gmail.com

Funding sources
This study was funded by the Danish Chiropractors' Foundation. The funder was not involved in the development of the study protocol, in the management of the study, in the analysis or interpretation of data, in the preparation of the study report, or in the decision to submit the article for publication. The original data collection was funded by Saskatchewan Government Insurance through a grant to the University of Saskatchewan.

Conflicts of interest
None declared.

Accepted for publication
7 January 2015

doi:10.1002/ejp.681

Abstract

Background: Traffic collisions often result in a wide range of symptoms included in the umbrella term whiplash-associated disorders. Mid-back pain (MBP) is one of these symptoms. The incidence and prognosis of different traffic injuries and their related conditions (e.g. neck pain, low back pain, depression or others) has been investigated previously; however, knowledge about traffic collision-related MBP is lacking. The study objectives were to describe the incidence, course of recovery and prognosis of MBP after traffic collisions, in terms of global self-reported recovery.
Methods: Longitudinal data from a population-based inception cohort of all traffic injuries occurring in Saskatchewan, Canada, during a 2-year period were used. Annual overall and age-sex-specific incidence rates were calculated, the course of recovery was described using the Kaplan–Meier technique, and associations between participant characteristics and time-to-self-reported recovery were explored in 3496 MBP cases using Cox proportional hazards models.
Results: The yearly incidence rate was 236 per 100,000 population during the study period, and was highest in women and in young persons. The median time-to-first reported recovery was 101 days (95% CI: 99–104) and about 23% were still not recovered after 1 year. Participant's expectation for recovery, general health, extent of severely affecting comorbidities and having experienced a previous traffic injury were some of the prognostic factors identified.
Conclusions: These findings show that MBP is common after traffic collisions, may result in a long recovery process and that a range of biopsychosocial factors are associated with recovery.

1. Introduction

The most common traffic-related injury, affecting about 50–80% of all injured individuals, is the whiplash injury (Cassidy et al., 2000). Individuals experiencing this type of injury often report a variety of clinical manifestations, described as Whiplash-Associated Disorders (WAD) (Spitzer et al., 1995). The annual cumulative incidence of WAD is likely to be between 300 and 600 per 100,000 inhabitants in North America and Western Europe (Cassidy et al., 2000; Holm et al., 2009). WAD reflects the reality that most whiplash patients experience other symptoms in addition to neck pain, such as pain in other areas of the spine, paraesthesia, fatigue,

What's already known about this topic?
- There are no previous published studies on the incidence, course and prognosis of mid-back pain (MBP) after traffic collisions.

What does this study add?
- Mid-back pain is a common complaint among those with traffic injuries and about 23% are not recovered 1 year after the collision.
- Recovery for those with MBP after traffic collisions is influenced by expectations for recovery, general health and the extent of severely affecting comorbid conditions.

nausea, cognitive problems, low self-reported physical and mental health (Ferrari et al., 2005), depressive mood and anxiety (Phillips et al., 2010), acute stress response (Kongsted et al., 2008) and pain in multiple sites (Bortsov et al., 2013), most commonly in the posterior trunk region (Hincapié et al., 2010).

About half of those with WAD report neck symptoms 1 year after the injury, indicating a prolonged recovery in a substantial proportion of these patients (Carroll et al., 2008). Neck pain intensity and self-reported disability are two of the characteristics most consistently reported to influence the prognosis of traffic injuries (Carroll et al., 2008; Walton et al., 2013). Early post-traumatic stress disorder symptoms and pain catastrophizing are likely also important (Walton et al., 2013), as well as depressive mood and anxiety (Phillips et al., 2010), expectations for recovery (Holm et al., 2008; Carroll et al., 2009) and pain coping strategies (Carroll et al., 2014). The wide range of prognostic factors indicates that whiplash injuries are complex in nature, involving biopsychosocial aspects of the patient and his or her life.

The mid back appears to be the least studied spinal region in research of both non-traumatic musculoskeletal pain and traffic injuries. Mid-back pain (MBP) has a 1-year prevalence of about 15% in the general population (Niemelainen et al., 2006; Leboeuf-Yde et al., 2009), and has consequences such as reduced physical activity and increased sick leave, to the same degree as low back or neck pain (Leboeuf-Yde et al., 2011, 2012). The prevalence of traffic collision-related MBP has been reported to be about 55% within hours to 6 weeks post-crash (Holm et al., 2007; Hincapié et al., 2010; Bortsov et al., 2013), indicating that it is a common symptom of WAD. Furthermore, pain in various body parts, including the mid back, have been identified in WAD patients with chronic neck pain (Wenzel et al., 2009; Myran et al., 2011), and are associated with a poor prognosis (Hartling et al., 2002). The incidence and prognosis of different traffic injuries and their related conditions have been investigated previously (Cassidy et al., 2003; Carroll et al., 2008; Phillips et al., 2010). However, no previous study has, to our knowledge, investigated these aspects specifically in relation to traffic collision-related MBP. The purpose of this study was to describe the incidence, course of recovery and prognosis of MBP after traffic collisions, in terms of global self-reported recovery, in the general adult population.

2. Methods

2.1. Study design, setting and population

A population-based, inception cohort study with 1-year follow-up of all adults residing in the Canadian province of Saskatchewan was undertaken between 1 December 1997 and 30 November 1999. Saskatchewan's population at the time of the study was approximately 1,000,000. In Saskatchewan, all drivers are required to have traffic injury insurance with Saskatchewan Government Insurance (SGI), the sole insurer of traffic injuries in the province. All traffic injury-related treatments in the province are funded by SGI, and Saskatchewan residents have universal coverage for this and all other health care. Study data were collected at baseline and then at 6 weeks, 3, 6, 9 and 12 months of follow-up. All injured persons completed the baseline questionnaire, and consenting participants were followed by computer-aided telephone interviews performed at an independent research centre at the University of Saskatchewan. Unidentified baseline questionnaire information was available to the researchers on all injured residents, and over 80% participated in the follow-up study. The research ethics boards of the Universities of Saskatchewan and Alberta gave ethics approval for the original study and the Danish Data Protection Agency approved the current analysis of the study data (approval no.: 2013-41-1767).

2.2. Cohort formation and study measures

The study included all adult residents that presented to a registered health care professional (i.e. medical doctor, chiropractor, physical therapist or massage therapist) in either a hospital or primary care setting

for treatment of their traffic collision-related injury. By law, these practitioners must notify SGI when they treat a traffic injury, and this results in an injury insurance claim. Entry into the cohort could also occur if the injured person notified SGI of a bodily injury, but did not attend a registered health care professional for treatment. Eligible study participants had to be 18 years of age or older, injured in a motor vehicle (i.e. excludes those injured as pedestrians, motor cyclists or bicyclists), able to answer a baseline questionnaire in English (i.e. comprehend English and not have an injury or disease so serious, such as Alzheimer's disease, that they were incapable of answering the questionnaire), a resident of Saskatchewan, and not have a work-related traffic injury (i.e. work-related injury claims are processed through the workers' compensation board).

For the present study, we excluded participants that made a claim more than 42 days after their collision, to avoid recall and time-zero bias, or were hospitalized for more than 2 days, to exclude more serious injuries. A sub-cohort of study participants with self-reported MBP at baseline was formed. MBP cases were defined by an answer of 'Yes' to the following question in the baseline questionnaire: 'Did the accident cause pain in the mid back?'.

2.2.1. Baseline questionnaire

The baseline questionnaire was part of the standard insurance procedure and was collected at entry into the cohort, and it included items from a range of different domains, covering socio-demographic characteristics (i.e. age, sex, height, weight, marital status, number of dependents, level of education and annual household income), collision circumstances (e.g. position in vehicle, direction of impact, headrest use, seat belt use and others), acquired injuries (e.g. fractures, head injury and others), symptoms and care-seeking behaviour (e.g. pain location and intensity, hospitalization, type of health care practitioner seen, other symptoms, loss of consciousness, post-traumatic amnesia, resulting disabilities, pain history and others), general health status (e.g. current comorbidities, depressive symptoms, general health status before and after the injury, expectations for recovery and others) and information about work and daily activities (e.g. work status, work satisfaction and others.). All information collected was self-reported on this paper questionnaire.

Pain intensity was measured using a numerical rating scale (NRS-11), ranging from 0 to 10, where 0 meant 'No pain at all' and 10 meant, 'Pain as bad as could be'. The health transition question and the overall general health question of the Medical Outcome Short Form-36 Health Survey (SF-36) (Ware and Sherbourne, 1992) were included, along with a question about general health prior to the collision. The Centre for Epidemiological Studies – Depression Scale (CES-D) was used to measure levels of depressive symptomatology, ranging from 0 to 60 (indicating a low to high level of depressive state) (Radloff, 1977). The psychometric properties of the NRS-11 (Jensen et al., 1986), reliability and validity of the SF-36 (Ware, 2000) and test–retest reliability and validity of the CES-D (Devins et al., 1988) have been investigated with good results. The presence and severity of comorbid conditions (Table 1) were measured using a previously validated inventory (Vermeulen, 2006).

2.2.2. Outcome

Self-reported recovery was collected by computer-aided telephone interviews throughout the follow-up period. Participants were classified as recovered the first time they responded 'All better or cured' or 'Feeling quite a bit of improvement' to the question 'How well do you feel you are recovering from your injuries?'. Those who responded 'Feeling some improvement', 'Feeling no improvement', 'Getting a little worse' or 'Getting much worse' were classified as not recovered. The test–retest reliability and criterion validity of this question has been investigated with good results (Ngo et al., 2010; Carroll et al., 2012).

2.2.3. Derived and modified variables

A categorical variable corresponding to subject's number of comorbidities self-reported to be severely affecting their health was derived using baseline information. Age was categorized into the following age groups: 18–23, 24–29, 30–39, 40–49 and ≥50 years. The cut-points were chosen to distribute subjects approximately equally across the age groups, and have been used in previous studies using this cohort.

2.3. Statistical analysis

The baseline characteristics of the cohort were described using medians with interquartile ranges (IQR) and frequencies with proportions (%). Medians were used instead of means because continuous variables had skewed distributions.

The annual overall, age- and sex-specific incidence rates of MBP per 100,000 population were calculated

Table 1 Baseline characteristics presented as frequencies with percentages or medians with interquartile ranges of 3711 Saskatchewan (Canada) residents with mid-back pain after traffic collisions occurring in 1997–1999.

Baseline characteristics	*n* (%)/Median (IQR)	Missing values
Women	2484 (66.9)	0
Age group (years)		
18–23	790 (21.3)	0
24–29	567 (15.3)	
30–39	894 (24.1)	
40–49	714 (19.2)	
≥50	746 (20.1)	
Median age (years)	35.7 (25.3–47.2)	
Marital status		
Single	1279 (34.5)	2
Married	1934 (52.1)	
Widowed	104 (2.8)	
Separated	392 (10.6)	
Education level		
High school graduate or lower	1713 (46.3)	10
More than high school graduate	1988 (53.7)	
Annual family household income (CAD)		
≤$20,000	1211 (33.6)	111
>$20,000 to ≤$40,000	1127 (31.3)	
>$40,000 to ≤$60,000	708 (19.7)	
>$60,000	554 (15.4)	
Number of dependents		
≤2	3267 (88.1)	1
≥3	443 (11.9)	
Pain location and median pain intensity score (NRS-11)		
Head	3001 (81.0)	4
Head pain intensity	6 (6–6)	38
Neck	3545 (95.3)	0
Neck pain intensity	7 (5–8)	44
Low back	2846 (76.8)	4
Low back pain intensity	6 (2–8)	43
Mid back	3711	0
Mid-back pain intensity	6 (5–8)	69
Arm	1824 (49.2)	3
Arm pain intensity	0 (0–5)	25
Hand	936 (25.2)	1
Hand pain intensity	0 (0–5)	22
Health now compared to 1 year ago		
Somewhat or much better, or about the same	1514 (40.9)	5
Somewhat or much worse	2192 (59.2)	
Number of severely affecting comorbidities[a], range 0–9		
0	2394 (64.9)	20
1	801 (21.7)	
2	300 (8.1)	
≥3	196 (5.3)	
Depressive symptoms		
Median CES-D score	16 (7.4–26.3)	109
Expectations for recovery		
Get better soon	736 (19.9)	4
Get better slowly	1583 (42.7)	
Never get better	88 (2.4)	
Do not know	1300 (35.1)	
Other symptoms experienced after the collision		
Pain when moving neck	3085 (83.1)	0
Sleeping problems	2645 (71.3)	
Reduced ability to move neck	2611 (70.4)	
Unusual fatigue or tiredness	1993 (53.7)	
Anxiety	1796 (48.4)	
Vertigo/dizziness	1754 (47.3)	
Irritability	1589 (42.8)	
Arm numbness	1584 (42.7)	
Concentration/attention problems	1057 (28.5)	
Leg numbness	1029 (27.7)	
Sore jaw	763 (20.6)	
Memory problems	666 (18.0)	
Post-crash amnesia, immediately after collision		
No	3130 (84.3)	0
Yes	270 (7.3)	
Do not know	311 (8.4)	
Previous injury claim (MVC); SGI		
No	2411 (69.1)	8
Yes	1077 (30.9)	
Previous injury claim (non-MVC); other insurance/disability plan		
No	2717 (77.83)	5
Yes	774 (22.2)	

n, the number corresponding to the characteristic; IQR, interquartile range; CAD, Canadian dollar; NRS-11 is numerical rating scale, CES-D, Centre for Epidemiological Studies – Depression Scale; MVC, motor vehicle collision; SGI, Saskatchewan Government Insurance (universal traffic insurer in Saskatchewan).

[a]Comorbidities includes non-traumatic musculoskeletal disorders, allergies, respiratory diseases, hypertension, cardiovascular diseases, gastrointestinal disorders, diabetes mellitus, renal or genitourinary diseases, neurological deficits, headaches, mental illnesses and cancer. The highest possible number of severely affecting comorbidities was 12.

with 95% confidence intervals (CI) for the time period 1 January 1998 to 31 December 1999, using the Saskatchewan mid-year population as the denominator. The mid-year populations used were based on data from the Saskatchewan government (Health insurance registration: covered population, 1997–1999. Regina, Saskatchewan). The age-specific incidences were reported using previously mentioned age groups.

The course of recovery was illustrated using the Kaplan–Meier technique and the median time-to-first reported recovery was calculated along with 95% CI. Cases lost to follow-up were censored halfway between their last follow-up and the next scheduled interview (Kirkwood and Sterne, 2003). Participants not recovered after 380 days were censored at this point.

Prognosis was modelled using the Cox proportional hazards model. The modelling process consisted of an explorative three-step reduction procedure based on the same principle: in each step, all baseline variables with a CI containing 1 were considered unimportant and were excluded from the analysis. Variables were included in the analysis based on an *a priori* defined conceptual framework of domains, inspection of Kaplan–Meier curves and an investigation of collinearity using Spearman's correlation coefficients. The modelling strategy and conceptual framework have previously been used (Cassidy et al., 2000), and is based on the biopsychosocial model and the WAD and musculoskeletal pain theory literature.

In the first step, univariate Cox proportional hazards models were constructed. Non-significant variables were excluded. In the next step, variables identified in the first step were combined into the following domain models: *anthropometric and sociodemographics* (i.e. age, body mass index, number of dependents, education level, marital status and work status), *pain-related* (i.e. pain intensity in the mid back, neck, low back, head, face, arm, hand, leg, foot and abdominal, chest or groin, and percentage of body in pain), *symptoms and injuries* (i.e. arm or leg numbness, vertigo, problems with memory, concentration, hearing, vision, or sleeping, irritability, unusual fatigue, anxiety, pain when moving neck, reduced ability to move neck, sore jaw, head trauma during the collision, and loss of consciousness, confusion or amnesia immediately after the collision), *general health status* (i.e. general health 1 month prior to injury, health now, health now vs. 1 year ago, and number of severely affecting comorbidities) and *psychosocial domain model* (i.e. baseline CES-D score, expectations for recovery, and previous motor vehicle collision (MVC) and non-MVC injury insurance claims); unimportant factors were again excluded. Variables that remained in the reduced domain models were combined into one model in the third step. Then, the same reduction procedure was applied resulting in the final model. Ninety per cent confidence intervals were used in step 1, whereas 95% CIs were used in steps 2 and 3.

The hazard rate ratio (HRR) estimates of the following interactions were assessed using a 90% CI: sex and spinal pain intensity; sex and depressive symptomatology; sleep disorder and depressive symptomatology; and spinal pain intensity and depressive symptomatology. These were chosen *a priori* based on previous research findings (Chiu et al., 2005; Phillips et al., 2010; Gerrits et al., 2014; Walton et al., 2013).

The potential effect of multiple collinearity in the domain models and in the final model was investigated using variance inflation factors based on multiple linear regression models. The model validation methods used to investigate the proportional hazards assumption have been recommended and described elsewhere (Bellera et al., 2010).

To identify potential sources of selection bias, participants of the final study population were compared to non-responding participants and to participants omitted from the multivariable analysis due to missing data. This was done by looking for overlapping CIs when comparing the group's proportions or medians with 95% CIs of the baseline characteristics. Stata IC version 13.1 was used in the analyses (StataCorp., 2013).

3. Results

Of the 8634 eligible traffic injury cases, 3711 fulfilled our MBP case definition. Of these, 215 (6%) were non-responders (i.e. not participating in any follow-up interview), leaving 3496 cases for analysis (Fig. 1). During the follow-up period, 335 of the 3496 study participants were lost to follow-up, resulting in a follow-up rate of 90%. Two thousand

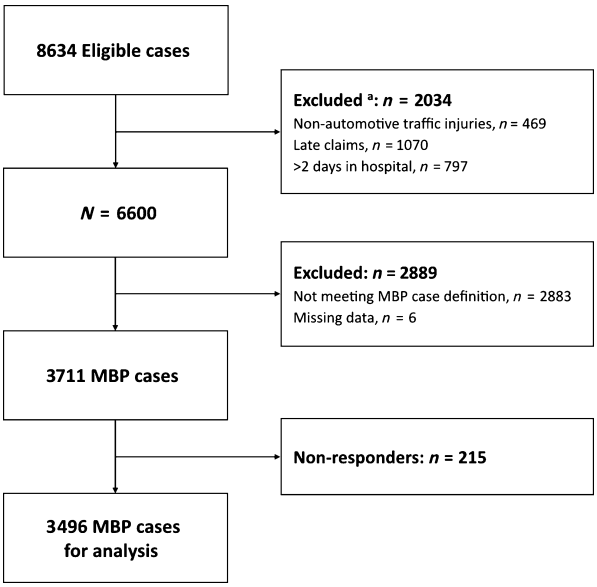

Figure 1 Formation of the mid-back pain cohort. MBP is mid-back pain, *N* is number of eligible cases, *n* is number of excluded cases. [a]Some excluded participants fulfilled more than one exclusion criteria and have been counted more than once.

and seventy-five cases (56%) participated in all follow-up interviews. The median time from the injury to completing the baseline questionnaire was 11 days (IQR: 6–18).

The cohort consisted of more women (67%) than men and the median age was 35.7 years (Table 1). Besides MBP, the most commonly reported pain sites were the neck (95%), head (81%) and low back (77%). Many participants (70%) reported both neck and low back pain in addition to MBP. Neck pain had the highest median pain intensity (NRS-11 score of 7). About 80% reported four or more pain sites (NRS-11 score of ≥3). Many (70%) stated their general health to be excellent, very good or good prior to the collision. After the collision, this had dropped to 10%. The most common expectation for recovery was to 'Get better slowly' (43%). Many of the participants experienced other symptoms after the collision, such as pain when moving their neck (83%), sleeping problems (71%) and reduced ability to move their neck (70%).

The overall average incidence rate of MBP was about 236.5 during the study period. In both years, a pattern of decreasing incidence with increasing age was observed, and women had higher incidence rates than men in all age groups (Table 2). The course of recovery is illustrated in Fig. 2. The median time-to-first reported recovery was 101 days (95% CI: 99–104), and about 23% were not recovered after 1 year.

Several baseline characteristics were associated with a poor recovery in the final model (Table 3). These included increasing age, having three or more dependents, increasing pain intensity in the low back, head and hands, poor current general health compared to 1 year ago, having three or more severely affecting comorbidities, poor expectations for recovery and having previous injury insurance claims (i.e. both traffic collision-related and non-traffic collision-related injury insurance claims). The participant's expectation for recovery was a strong prognostic factor, and those answering 'Never get better', 'Don't know' and 'Get better slowly' were much less likely to be recovered compared to those answering 'Get better soon' (HRR: 0.28, 95% CI: 0.19–0.40; 0.51, 0.45–0.57; and 0.72, 0.65–0.80, respectively).

None of the interactions explored were associated with recovery. Because the focus was on MBP, the corresponding baseline pain intensity measure was forced into and throughout the third step of the modelling process. The final model was refitted using age groups (i.e. an ordinal variable instead of age as a continuous variable; HRR age: 0.994, 95% CI:

Table 2 Incidence rates of mid-back pain per 100,000 population with 95% confidence intervals and incident number of mid-back pain after traffic collisions occurring in Saskatchewan (Canada) during a 2-year period (1998–1999), stratified by year of accrual, sex and age group.

	Age group (years)					
Sex	18–23	24–29	30–39	40–49	≥50	Overall
Year 1						
Men	244.6 (203.9–293.4) n = 116	200.8 (161.7–249.3) n = 82	196.0 (167.0–230.2) n = 149	162.5 (136.1–194.0) n = 122	85.2 (71.0–102.2) n = 116	155.8 (143.7–169.0) n = 585
Women	558.1 (493.0–631.7) n = 250	498.9 (433.8–573.9) n = 196	384.8 (343.1–431.6) n = 292	324.2 (285.3–368.4) n = 235	150.5 (132.4–171.1) n = 233	311.4 (294.3–329.5) n = 1206
Both sexes	396.9 (358.2–439.7) n = 366	347.0 (308.5–390.2) n = 278	290.3 (264.5–318.7) n = 441	241.9 (218.1–268.4) n = 357	120.0 (108.0–133.2) n = 349	234.8 (224.2–245.9) n = 1791
Year 2						
Men	293.6 (261.8–329.1) n = 141	225.1 (197.5–256.5) n = 93	195.2 (169.7–224.6) n = 148	141.5 (120.0–166.9) n = 108	83.6 (67.4–103.6) n = 114	159.8 (136.9–186.6) n = 604
Females	587.7 (542.0–637.2) n = 265	466.5 (426.0–510.8) n = 184	372.2 (336.2–412.0) n = 280	317.0 (283.9–353.9) n = 233	166.8 (143.3–194.2) n = 259	314.3 (281.4–351.0) n = 1221
Both sexes	436.0 (396.9–478.9) n = 406	343.0 (308.5–381.3) n = 277	283.4 (252.2–318.3) n = 428	227.6 (199.9–259.2) n = 341	127.9 (107.5–152.1) n = 373	238.1 (209.7–270.4) n = 1825

n is the absolute number of incident mid-back pain. Incidence rates were calculated using the Saskatchewan mid-year population as denominator.

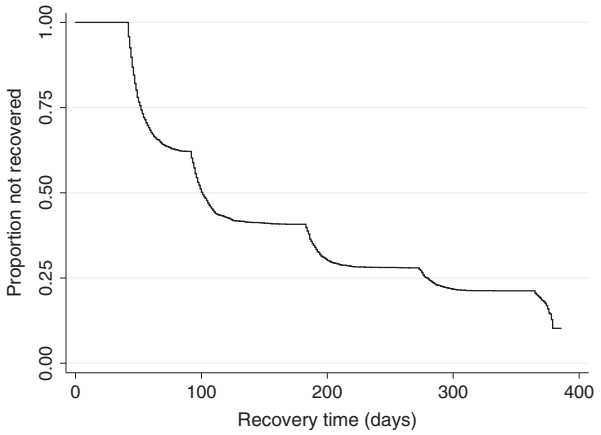

Figure 2 Course of recovery. The Kaplan–Meier curve illustrates the course of recovery from mid-back pain after traffic collisions for 3496 Saskatchewan (Canada) residents. The median time-to-first reported recovery was 101 days (95% CI: 99–104).

0.991–0.997) for interpretational reasons. There were no indications of multiple collinearity in any of the models, and the model validation did not reveal any signs of violation of the proportional hazards assumption.

The 215 non-responding participants (5.8%) were statistically significant different from the responding participants on certain demographic and health-related characteristics. There was a difference in sex distribution (non-responders: 41.9% men vs. responders: 32.5% men), marital status (43.7% married and 16.7% separated vs. 52.7% and 10.2%), annual household income (46.8% ≤$20,000 and 13.3% >$40,000 to ≤$60,000 vs. 32.9% and 20.0%), self-rated general health after the collision (71.0% fair or poor vs. 63.9%), number of severely affecting comorbidities (58.3% none and 10.0% ≥3 vs. 65.3% and 5.0%), depressive symptoms (median CES-D score of 20 vs. 15), memory problems (25.1% vs. 17.5%), irritability (51.6% vs. 42.3%), anxiety (56.3% vs. 47.9%) and post-crash amnesia (79.5% no vs. 84.6%).

There were 142 participants (4.1%) omitted from the final model due to missing data. These participants were statistically significant different from the analysed participants on the following characteristics: median age (omitted cases: 39.5 years vs. analysed cases: 35.6 years), annual household income (23.9% >$60,000 vs. 15.2%), reporting of hand pain (33.3% vs. 24.8%) and leg pain (49.6% vs. 39.5%), self-rated health 1 month prior to the collision (14.1% fair or poor vs. 6.9%), number of severely affecting

Table 3 Prognostic factors, with crude and adjusted hazard rate ratios and confidence intervals, associated with time-to-self-reported recovery in 3354 Saskatchewan (Canada) residents with mid-back pain after traffic collisions occurring in 1997–1999, analysed using a Cox proportional hazards model.

Prognostic factors	Crude HRR (90% CI)	Adjusted HRR (95% CI)
Age group (years)		
18–23	(Reference level)	(Reference level)
24–29	0.955 (0.844–1.079)	1.053 (0.928–1.195)
30–39	0.792 (0.708–0.886)[a]	0.888 (0.788–1.001)
40–49	0.749 (0.666–0.843)[a]	0.840 (0.742–0.951)[a]
≥50	0.698 (0.620–0.785)[a]	0.788 (0.696–0.891)[a]
Number of dependents		
≤2	(Reference level)	(Reference level)
≥3	0.813 (0.734–0.899)[a]	0.833 (0.731–0.948)[a]
Mid-back pain intensity (NRS-11)[b]	0.907 (0.894–0.921)[a]	1.000 (0.979–1.022)
Low back pain intensity (NRS-11)	0.931 (0.922–0.940)[a]	0.960 (0.948–0.973)[a]
Head pain intensity (NRS-11)	0.925 (0.917–0.934)[a]	0.956 (0.944–0.968)[a]
Hand pain intensity (NRS-11)	0.936 (0.924–0.948)[a]	0.970 (0.954–0.986)[a]
Health now compared to 1 year ago		
Somewhat or much better, or about the same	(Reference level)	(Reference level)
Somewhat or much worse	0.629 (0.590–0.671)[a]	0.781 (0.720–0.848)[a]
Number of severely affecting comorbidities[c]		
0	(Reference level)	(Reference level)
1	0.879 (0.812–0.951)[a]	0.961 (0.872–1.059)
2	0.733 (0.646–0.831)[a]	0.961 (0.821–1.124)
≥3	0.519 (0.436–0.617)[a]	0.719 (0.579–0.893)[a]
Expectations for recovery		
Get better soon	(Reference level)	(Reference level)
Get better slowly	0.612 (0.564–0.663)[a]	0.717 (0.647–0.795)[a]
Never get better	0.204 (0.152–0.273)[a]	0.279 (0.195–0.399)[a]
Do not know	0.397 (0.364–0.434)[a]	0.506 (0.451–0.567)[a]
Previous injury claim (MVC); SGI		
No	(Reference level)	(Reference level)
Yes	0.642 (0.597–0.690)[a]	0.716 (0.654–0.783)[a]
Previous injury claim (non-MVC); other insurance/disability plan		
No	(Reference level)	(Reference level)
Yes	0.808 (0.747–0.875)[a]	0.869 (0.787–0.958)[a]

HRR, hazard rate ratio; CI, confidence interval; NRS-11, numerical rating scale; MVC, motor vehicle collision; SGI, Saskatchewan Government Insurance (universal traffic insurer in Saskatchewan).

[a]Confidence intervals not containing 1.

[b]Mid-back pain intensity was forced in the model during the modelling process.

[c]Comorbidities includes non-traumatic musculoskeletal disorders, allergies, respiratory diseases, hypertension, cardiovascular diseases, gastrointestinal disorders, diabetes mellitus, renal or genitourinary diseases, neurological deficits, headaches, mental illnesses and cancer, the highest possible number of severely affecting comorbidities was 12.

comorbidities (9.5% ≥3 vs. 4.9%), reporting of leg numbness (35.2% vs. 27.3%) and reporting of a previous MVC-related injury (40.3% vs. 30.5%).

4. Discussion

This study shows that MBP is a common symptom after traffic collisions, with the highest incidence rates identified in women and in younger individuals. The recovery time for traffic injuries is long for a large proportion of affected persons and factors with the strongest associations with an extended time-to-recovery were poor baseline recovery expectations, a previous traffic injury and the number of severely affecting comorbidities. We systematically searched MEDLINE using Scopus and found no previous studies focused on the incidence or prognosis of MBP after traffic collisions (contact corresponding author for details regarding search strategy).

The incidence rates of MBP found in this cohort are lower compared to what is known from studies of neck (Carroll et al., 2008; Styrke et al., 2012) and low back pain (Cassidy et al., 2003) after traffic collisions. However, the pattern of higher incidence rates in women and in younger individuals observed in this cohort has been found previously (Cassidy et al., 2000; Styrke et al., 2012). Women seem to be at an increased risk of WAD, and young age has been identified as a risk factor for development of WAD (Holm et al., 2009). Our findings corroborate these previous results.

About 23% of our cohort was not recovered after 1 year, which is a smaller proportion than what has been estimated for neck pain recovery following MVCs (Carroll et al., 2008). The median recovery time was found to be slightly above 3 months, which underscores that some individuals with MBP after traffic collisions can experience a long recovery process.

As previously mentioned, neck pain intensity is one of the most consistently found prognostic factors in WAD (Walton et al., 2013); however, in our cohort, pain intensity was not a strong prognostic factor. MBP intensity in particular was not associated with self-reported global recovery, while the pain intensity in other parts of the body (i.e. low back, head and hand) was only weakly associated with outcome. This finding is unusual, but reflects the multidimensional character of WAD (Ferrari et al., 2005). Even though all participants reported MBP in this cohort, their primary complaint is unknown and cannot be taken into account in the analysis.

The number of severely affecting comorbid conditions and self-rated health now compared to 1 year ago was identified as prognostic factors in our cohort, which is consistent with similar study results (Wenzel et al., 2012; Myrtveit et al., 2013). These are interesting findings since they suggest that the participant's general health, including comorbid health conditions, may influence the recovery process to a greater extent than specific injury characteristics such as location-specific pain intensity. Poor recovery expectations have previously been identified as a prognostic factor in traffic injuries (Holm et al., 2008; Carroll et al., 2009) and in non-traumatic pain conditions such as low back pain (Kongsted et al., 2014). The experience of previous injury claims (i.e. both MVC- and non-MVC-related injuries) was also associated with a slower recovery rate. Evidence regarding the role of prior injuries and prior pain in the prognosis of traffic injuries is currently inconclusive (Carroll et al., 2008; Walton et al., 2013). However, these findings raise questions about a possible pre-collision vulnerability of a poor prognosis. Janzen et al. (2006) suggest that patients' prior understanding (i.e. experiences, beliefs and knowledge) and several cognitive processes are involved in the development of health expectations. It is plausible that severely affecting comorbidities and previous injury experiences could constitute a set of pre-collision vulnerability factors, contributing to the development of poor recovery expectations through such mechanisms.

4.1. Strengths and limitations

Since this is a population-based study, follow-up data were lacking for 5.8% (i.e. non-responders) and the proportion of missing data was low; selection bias is not likely affecting our results. The follow-up period seems to have been long enough for most participants to recover. Furthermore, the baseline data were collected shortly after the collision across a wide range of variables using valid and reliable measurements.

The outcome measure self-reported global recovery was associated with incrementally improved scores on other relevant recovery measures, such as pain intensity, pain-related disability, depressive symptoms and good physical health in a recent study (Carroll et al., 2012); suggesting that this measure is a good proxy for other unidimensional recovery definitions commonly used in WAD research (Walton, 2009). However, it should be emphasized that the outcome measure is an overall measure of recovery,

and not specifically related to the recovery from pain in a constrained body region.

It should also be emphasized that this is an exploratory prognostic study, investigating factors associated with recovery and not prognostic determinants or predictors (Hayden et al., 2008; Riley et al., 2013). However, our findings form a fundamental base of knowledge to inform future investigations concerning the causal pathways of recovery and the development of clinical prediction for recovery.

This study has some limitations that should be mentioned. The questions regarding pain localization in the baseline questionnaire (i.e. used in the MBP case definition) were not supplemented with a body diagram showing the area of interest, which could have affected their precision and potentially caused some misclassification of the pain location. The MBP cases were not defined by any level of pain intensity, but only by the presence of pain. This could have included some cases with clinically unimportant pain. However, the median MBP intensity score (NRS-11) was 6 and only 4.7% reported a NRS-11 score of 2 or less, suggesting it was clinically important for most subjects. Pain present prior to a traffic collision could be aggravated by, or misattributed to a subsequent collision, and thereby affect incidence estimates of traffic injuries. If the pain condition is highly prevalent in the general population, the risk of biased estimates may be higher compared to pain conditions of lower prevalence, such as MBP (Hartvigsen et al., 2013).

4.2. Clinical and research implications

This study contributes with novel insights about the incidence and prognosis of MBP after traffic collisions. Clinicians should be aware that the recovery from MBP is slow and likely influenced by factors other than pain in the mid back. We also emphasize the importance to look beyond the neck in patients with traffic injuries, since they typically present with a widespread pain pattern, similar to what is seen in non-traumatic musculoskeletal pain conditions (Kamaleri et al., 2008). Our results lend further support for approaching traffic injury prognosis within a biopsychosocial model of recovery. In particular, we have found that poor expectation for recovery is important, and this might be a good focus for future intervention studies.

5. Conclusions

Mid-back pain after traffic collisions is common, especially in women and in young individuals. A substantial proportion of participants in this cohort experienced a delayed recovery. Prognostic factors with the strongest influence on recovery were poor expectations for recovery and having a previous experience of a traffic injury.

Author contributions

J.D.C., M.S.J. and J.H. contributed to the conception and design of the study. J.D.C. and L.C. designed the original study and acquired the data. M.S.J. performed the analyses, the initial data interpretation, and formulated and developed the manuscript. E.B. assisted with the statistical analyses. J.D.C., E.B., M.J.S., L.C. and J.H. contributed with critical revising during the development of the manuscript. All authors have discussed the results and have given approval to the publishing of the final version of the manuscript.

References

Bellera, C.A., MacGrogan, G., Debled, M., de Lara, C.T., Brouste, V., Mathoulin-Pelissier, S. (2010). Variables with time-varying effects and the Cox model: Some statistical concepts illustrated with a prognostic factor study in breast cancer. *BMC Med Res Methodol* 10, 20.

Bortsov, A.V., Platts-Mills, T.F., Peak, D.A., Jones, J.S., Swor, R.A., Domeier, R.M., Lee, D.C., Rathlev, N.K., Hendry, P.L., Fillingim, R.B., McLean, S.A. (2013). Pain distribution and predictors of widespread pain in the immediate aftermath of motor vehicle collision. *Eur J Pain* 17, 1243–1251.

Carroll, L.J., Holm, L.W., Hogg-Johnson, S., Cote, P., Cassidy, J.D., Haldeman, S., Nordin, M., Hurwitz, E.L., Carragee, E.J., van der Velde, G., Peloso, P.M., Guzman, J., Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders (2008). Course and prognostic factors for neck pain in whiplash-associated disorders (WAD): Results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine (Phila Pa 1976)* 33: S83–S92.

Carroll, L.J., Holm, L.W., Ferrari, R., Ozegovic, D., Cassidy, J.D. (2009). Recovery in whiplash-associated disorders: Do you get what you expect? *J Rheumatol* 36, 1063–1070.

Carroll, L.J., Jones, D.C., Ozegovic, D., Cassidy, J.D. (2012). How well are you recovering? The association between a simple question about recovery and patient reports of pain intensity and pain disability in whiplash-associated disorders. *Disabil Rehabil* 34, 45–52.

Carroll, L.J., Ferrari, R., Cassidy, J.D., Cote, P. (2014). Coping and recovery in whiplash-associated disorders: Early use of passive coping strategies is associated with slower recovery of neck pain and pain-related disability. *Clin J Pain* 30, 1–8.

Cassidy, J.D., Linda, J.C., Coté, P., Lemstra, M., Berglund, A., Nygren, A. (2000). Effect of eliminating compensation for pain and suffering on the outcome of insurance claims for whiplash injury. *N Engl J Med* 342, 1179–1186.

Cassidy, J.D., Carroll, L., Cote, P., Berglund, A., Nygren, A. (2003). Low back pain after traffic collisions: A population-based cohort study. *Spine (Phila Pa 1976)* 28, 1002–1009.

Chiu, Y.H., Silman, A.J., Macfarlane, G.J., Ray, D., Gupta, A., Dickens, C., Morriss, R., McBeth, J. (2005). Poor sleep and depression are independently associated with a reduced pain threshold. Results of a population based study. *Pain* 115, 316–321.

Devins, G.M., Orme, C.M., Costello, C.G., Binik, Y.M., Frizzell, B., Stam, H.J., Pullin, W.M. (1988). Measuring depressive symptoms in illness populations: Psychometric properties of the Center for Epidemiologic Studies Depression (CES-D) Scale. *Psychol Health* 2, 139–156.

Ferrari, R., Russell, A.S., Carroll, L.J., Cassidy, J.D. (2005). A re-examination of the whiplash associated disorders (WAD) as a systemic illness. *Ann Rheum Dis* 64, 1337–1342.

Gerrits, M.M., van Oppen, P., van Marwijk, H.W., Penninx, B.W., van der Horst H.E. (2014). Pain and the onset of depressive and anxiety disorders. *Pain* 155, 53–59.

Hartling, L., Pickett, W., Brison, R.J. (2002). Derivation of a clinical decision rule for whiplash associated disorders among individuals involved in rear-end collisions. *Accid Anal Prev* 34, 531–539.

Hartvigsen, J., Davidsen, M., Hestbaek, L., Sogaard, K., Roos, E.M. (2013). Patterns of musculoskeletal pain in the population: A latent class analysis using a nationally representative interviewer-based survey of 4817 Danes. *Eur J Pain* 17, 452–460.

Hayden J.A., Cote P., Steenstra I.A., Bombardier C., Quips-LBP Working Group (2008). Identifying phases of investigation helps planning, appraising, and applying the results of explanatory prognosis studies. *J Clin Epidemiol* 61, 552–560.

Hincapié, C.A., Cassidy, J.D., Côté, P., Carroll, L.J., Guzmán, J. (2010). Whiplash injury is more than neck pain: A population-based study of pain localization after traffic injury. *J Occup Environ Med* 52, 434–440.

Holm, L.W., Carroll, L.J., Cassidy, J.D., Skillgate, E., Ahlbom, A. (2007). Widespread pain following whiplash-associated disorders: Incidence, course, and risk factors. *J Rheumatol* 34, 193–200.

Holm, L.W., Carroll, L.J., Cassidy, J.D., Skillgate, E., Ahlbom, A. (2008). Expectations for recovery important in the prognosis of whiplash injuries. *PLoS Med* 5, e105.

Holm, L.W., Carroll, L.J., Cassidy, J.D., Hogg-Johnson, S., Cote, P., Guzman, J., Peloso, P., Nordin, M., Hurwitz, E., van der Velde, G., Carragee, E., Haldeman, S. (2009). The burden and determinants of neck pain in whiplash-associated disorders after traffic collisions: Results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *J Manipulative Physiol Ther* 32, S61–S69.

Janzen, J.A., Silvius, J., Jacobs, S., Slaughter, S., Dalziel, W., Drummond, N. (2006). What is a health expectation? Developing a pragmatic conceptual model from psychological theory. *Health Expect* 9, 37–48.

Jensen, M.P., Karoly, P., Braver, S. (1986). The measurement of clinical pain intensity: A comparison of six methods. *Pain* 27, 117–126.

Kamaleri, Y., Natvig, B., Ihlebaek, C.M., Bruusgaard, D. (2008). Localized or widespread musculoskeletal pain: Does it matter? *Pain* 138, 41–46.

Kirkwood B.R., Sterne J.A.C. (2003). *Essential Medical Statistics*, 2nd edn (Oxford: Blackwell Science Ltd).

Kongsted, A., Bendix, T., Qerama, E., Kasch, H., Bach, F.W., Korsholm, L., Jensen, T.S. (2008). Acute stress response and recovery after whiplash injuries. A one-year prospective study. *Eur J Pain* 12, 455–463.

Kongsted, A., Vach, W., Axo, M., Bech, R.N., Hestbaek, L. (2014). Expectation of recovery from low back pain: A longitudinal cohort study investigating patient characteristics related to expectations and the association between expectations and 3-month outcome. *Spine (Phila Pa 1976)* 39, 81–90.

Leboeuf-Yde, C., Nielsen, J., Kyvik, K.O., Fejer, R., Hartvigsen, J. (2009). Pain in the lumbar, thoracic or cervical regions: Do age and gender matter? A population-based study of 34,902 Danish twins 20-71 years of age. *BMC Musculoskelet Disord* 10, 39.

Leboeuf-Yde, C., Fejer, R., Nielsen, J., Kyvik, K.O., Hartvigsen, J. (2011). Consequences of spinal pain: Do age and gender matter? A Danish cross-sectional population-based study of 34,902 individuals 20-71 years of age. *BMC Musculoskelet Disord* 12, 39.

Leboeuf-Yde, C., Fejer, R., Nielsen, J., Kyvik, K.O., Hartvigsen, J. (2012). Pain in the three spinal regions: The same disorder? Data from a population-based sample of 34,902 Danish adults. *Chiropr Man Ther* 20, 11.

Myran, R., Hagen, K., Svebak, S., Nygaard, O., Zwart, J.A. (2011). Headache and musculoskeletal complaints among subjects with self reported whiplash injury: The HUNT-2 study. *BMC Musculoskelet Disord* 12, 129.

Myrtveit, S.M., Skogen, J.C., Petrie, K.J., Wilhelmsen, I., Wenzel, H.G., Sivertsen, B. (2013). Factors related to non-recovery from Whiplash. The Nord-Trondelag Health Study (HUNT). *Int J Behav Med* 21, 430–438.

Ngo, T., Stupar, M., Cote, P., Boyle, E., Shearer, H. (2010). A study of the test-retest reliability of the self-perceived general recovery and self-perceived change in neck pain questions in patients with recent whiplash-associated disorders. *Eur Spine J* 19, 957–962.

Niemelainen, R., Videman, T., Battie, M.C. (2006). Prevalence and characteristics of upper or mid-back pain in Finnish men. *Spine (Phila Pa 1976)* 31, 1846–1849.

Phillips, L.A., Carroll, L.J., Cassidy, J.D., Cote, P. (2010). Whiplash-associated disorders: Who gets depressed? Who stays depressed? *Eur Spine J* 19, 945–956.

Radloff, L.S. (1977). The CES-D Scale: A Self-Report Depression Scale for research in the general population. *Appl Psychol Meas* 1, 385–401.

Riley, R.D., Hayden, J.A., Steyerberg, E.W., Moons, K.G., Abrams, K., Kyzas, P.A., Malats, N., Briggs, A., Schroter, S., Altman, D.G., Hemingway, H. (2013). Prognosis Research Strategy (PROGRESS) 2: Prognostic factor research. *PLoS Med* 10, e1001380.

Spitzer, W.O., Skovron, M.L., Salmi, L.R., Cassidy, J.D., Duranceau, J., Suissa, S., Zeiss, E., Weinstein, J.N., Nogbuk, N. (1995). Scientific monograph of the Quebec Task Force on whiplash-associated disorders: Redefining 'Whiplash' and its management. *Spine* 20, 2S–73S.

StataCorp. 2013. *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP.

Styrke, J., Stalnacke, B.M., Bylund, P.O., Sojka, P., Bjornstig, U. (2012). A 10-year incidence of acute whiplash injuries after road traffic crashes in a defined population in northern Sweden. *PM R* 4, 739–747.

Vermeulen, S. (2006). Assessing the performance of a self-report comorbidity scale [MSc dissertation] (Edmonton: School of Public Health, University of Alberta).

Walton, D. (2009). A review of the definitions of 'recovery' used in prognostic studies on whiplash using an ICF framework. *Disabil Rehabil* 31, 943–957.

Walton, D.M., Carroll, L.J., Kasch, H., Sterling, M., Verhagen, A.P., Macdermid, J.C., Gross, A., Santaguida, P.L., Carlesso, L. (2013). An overview of systematic reviews on prognostic factors in neck pain: Results from the International Collaboration on Neck Pain (ICON) Project. *Open Orthop J* 7, 494–505.

Ware J.E Jr. (2000). SF-36 health survey update. *Spine (Phila Pa 1976)* 25, 3130–3139.

Ware, J.E. Jr, Sherbourne, C.D. (1992). The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 30, 473–483.

Wenzel, H.G., Mykletun, A., Nilsen, T.I. (2009). Symptom profile of persons self-reporting whiplash: A Norwegian population-based study (HUNT 2). *Eur Spine J* 18, 1363–1370.

Wenzel, H.G., Vasseljen, O., Mykletun, A., Nilsen, T.I. (2012). Pre-injury health-related factors in relation to self-reported whiplash: Longitudinal data from the HUNT study, Norway. *Eur Spine J* 21, 1528–1535.