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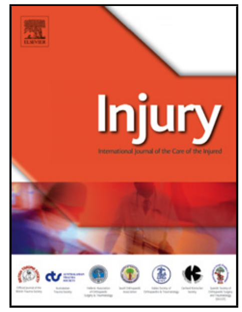

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Author: Justin Kenardy Michelle Heron-Delaney Jacelle Warren Erin Brown

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The effect of mental health on long-term health-related quality of life following a road traffic crash: Results from the UQ SuPPORT study

Justin Kenardy PhD[1], Michelle Heron-Delaney PhD[1, 2], Jacelle Warren MSc[1], Erin Brown BPsySc[1]

[1] Centre of National Research on Disability and Rehabilitation Medicine (CONROD), School of Medicine, The University of Queensland, Brisbane, Queensland, Australia

[2]School of Psychology, Australian Catholic University, Brisbane, Queensland, Australia

Correspondence to: Professor Justin Kenardy, CONROD, Level 1 Edith Cavell Building, The University of Queensland, Herston Q 4029, Australia; Ph: +61 7 3346 4859; Email: j.kenardy@uq.edu.au

The effect of mental health on long-term health-related quality of life following a road traffic crash: Results from the UQ SuPPORT study

Abstract

Background: Most research on the consequences of road traffic crashes (RTCs) has focused on serious injury cohorts, yet RTC survivors with minor injury are also affected. This study investigates the relationship between mental health and health-related quality of life (QoL) following an RTC for those with predominately minor injuries.

Methods: A longitudinal cohort design with an opt-in consenting procedure was used. A letter of invitation was sent to 3,146 claimants within the Compulsory Third Party (CTP) motor vehicle insurance scheme in Queensland, Australia, with a total of 382 (12%) responding to the invitation and consenting to participate in the study. Retention was high (65%) at 24 months. Survey and telephone interview data were collected at approximately 6, 12 and 24 months post-RTC. Health-related QoL (SF-36 v2) data from at least one wave was known for 343 participants. The sample was predominantly female (62%), with an average age of 48.6 years.

Results: Participants consistently reported physical and mental health-related QoL below Australian norms. A multilevel regression analysis found overall physical health-related QoL improved with higher expectations of returning to work, but was lower with age, increasing pain, expectations of persistent pain, heightened perceived threat to life, and the presence of Posttraumatic Stress Disorder (PTSD) or Major Depressive Episode (MDE). Overall, mental health-related QoL did not improve with time, was higher with increased social support and expectations of returning to work, but was lower with increasing pain and the presence of PTSD, MDE or Generalised Anxiety Disorder (GAD). Contrary to expectations, lower injury severity was related to poorer mental health-related QoL.

Conclusions: Individuals with predominately minor RTC-related injuries have poor physical and mental health-related QoL, particularly when pain levels are high and comorbid psychiatric disorders are present. Of particular concern is that the low levels of reported health-related QoL do not appear to improve by 2 years post-RTC. The potential risk factors found in this study may be useful indicators for early identification and enhanced rehabilitation of those at risk of poor recovery.

Keywords: Posttraumatic stress; depression; road traffic crashes; minor injury; quality of life; mental health; pain

Introduction

The World Health Organisation[1] has estimated that up to 50 million people worldwide suffer a non-fatal injury from a road traffic crash (RTC) each year, leading to long-term impairment in many individuals. In Australia, the majority of RTC victims survive with minor injuries which do not require hospitalisation[2]. Nonfatal RTC injuries have physical, emotional and economic repercussions for individuals, families, and society[3]. Further, the consequences may be long-lasting, with some research suggesting victims have not recovered to pre-crash health by 18 months post-RTC[4]. In addition, lost quality of life (QoL) has been described as a major part of RTC burden, therefore research exploring factors that impact QoL following an RTC may help define areas for intervention[1].

QoL research on RTC survivors has mostly focused on those with serious injuries[4, 5], however, RTC survivors with minor injuries also appear to suffer serious consequences. QoL is often measured using the Short Form 36 (SF-36)[6], which provides mental, as well as physical, health-related QoL component scores. To date, research on minor RTC injury and QoL is scarce. A small (*n*=95) study using a minor RTC injury cohort recruited through a hospital emergency department found baseline physical component scores (PCS) to be 1-1.5 standard deviations (SD) below Australian norms, and mental component scores (MCS) to be 1.5-2 SD below Australian norms[7]. Follow-up at 6 months showed some improvement (PCS: 0-0.5 SD below norm, MCS: 0.5-1 SD below norm), but no further improvement was found when the sample was re-examined at 12 months post-RTC. Additionally, those who claimed compensation reported worse PCS and MCS scores than those not claiming compensation. This research suggests physical and mental health-related QoL is affected long term, even when the RTC injury is classified as 'minor'.

More widely, research comparing hospitalised (i.e., more severely injured) and non-hospitalised (i.e., less severely injured) drivers injured in an RTC found scores on the SF-36 mental and general health subscales were worse at 5 to 18 months after the RTC, when compared with the initial assessment, in both groups[4]. This finding suggests injury severity may not predict later QoL, as has been found elsewhere[8]. Other research with serious injury cohorts has also found QoL reductions over time. In a small sample (*n*=62) with serious RTC injury, significantly reduced QoL was found across the eight SF-36 domains at 4 months post-RTC (0.3-1.8 SD below Australian norms), with some improvement found at 8 months post-RTC (0.1-0.5 SD below norms)[5]. Further, general trauma research with admitted patients has reported reduced QoL up to two years post-RTC[9]. These authors noted that significant improvements were found up to one year post-injury, however, only physical functioning and physical limitations continued to improve through the second year post-injury.

Mental health is a second area important in the study of injured RTC populations. Rates of posttraumatic stress disorder (PTSD; 6-45%) in RTCs have been extensively reported[10], however rates for other psychological disorders are not as readily available. Research using self-reported symptom questionnaires from RTC samples estimate the incidence of depressive symptoms to be 10 percent[11], anxiety symptoms to be 36 percent[12], and travel phobia to be 20 percent[11]. The comorbidity between psychiatric illness and QoL has been extensively researched. A recent systematic review found PTSD to very strongly impair QoL in a variety of populations[13], and specific to RTCs, researchers have found the presence of PTSD to predict poorer QoL at one year post-RTC[14]. In general injury cohorts, diagnosed depression was closely associated with reduced QoL[15, 16], as was high scores on the Hospital

Anxiety and Depression Scale (HADS)[17]. There is a clear relationship between the presence of mental illness and reported QoL, however, while others have used scores on screening questionnaires as a measure of mental illness[7], there has been no research to date which examines the relationship between QoL and mental health diagnosis in a RTC sample with predominately minor injuries. Therefore, it remains unclear how QoL in a RTC cohort with predominately minor injuries is affected by diagnosed mental illness.

Other potential factors that influence post-RTC QoL include expectations regarding recovery, self-reported pain levels, and social support. Work by Cole and colleagues found injured workers with high recovery expectations reported lower pain levels and higher QoL, compared to workers with low recovery expectations[18]. Other research has found greater social support predicts higher QoL post-injury[16], and an indirect negative relationship between PTSD and social support in an RTC sample[19]. The relationship between pain and QoL has also been extensively studied in many populations. Pain affects both physical and emotional QoL domains, with the effect of pain dependent on the intensity and duration of the pain, as well as the individual's characteristics[20]. These factors may all influence QoL in our RTC sample.

Overall, the objective of this study was to explore the relationship between mental health and health-related QoL following an RTC for claimants with predominately minor injuries in an Australian sample. The aims of the study are to (1) assess the level of health-related QoL reported during the 2 years post-RTC in the cohort of motor vehicle insurance claimants with predominantly minor injuries; and (2) evaluate the effects of physical, psychological and social factors (e.g., expectations regarding return to work) on self-reported levels of health-related QoL.

Materials and Methods

Participants and Procedure

This analysis forms part of The University of Queensland Study of Physical and Psychological Outcomes for claimants with predominately minor injuries following a Road Traffic crash (UQ SuPPORT). UQ SuPPORT is a longitudinal cohort study of claimants within a common law 'fault-based' Compulsory Third Party (CTP) motor vehicle insurance scheme in Queensland regulated by the Motor Accident Insurance Commission (MAIC). Survey and telephone interview data were collected at approximately 6, 12 and 24 months post-RTC. The UQ SuPPORT study protocol has been fully detailed elsewhere[21]. Briefly, potential participants were identified from records held by MAIC across an 18 month period (April 2009 - September 2010). Eligibility criteria were: (1) Driver/passenger of a car/motorcycle, cyclist, or pedestrian involved in an RTC, (2) sustained predominately minor physical injury with a maximum severity of ≤ 3 on the Abbreviated Injury Scale (AIS), (3) aged 18 years or older, (4) sufficient English speaking ability, (5) RTC occurred during the three months prior to claim notification, and (6) resident of Australia. Exclusion criteria were: (1) cognitive impairment (subjectively assessed by trained interviewers based on the participants' capacity to answer questions during the initial interview), and (2) a severe physical condition preventing the participant from completing the interview or survey (e.g., stroke, paralysis). Eligible participants were sent a letter by MAIC inviting them to participate in the study, and were able to opt-in by returning the accompanying consent form in a reply-paid envelope. This method of recruiting eligible claimants was governed by legislative requirements. Given the 'common law' nature of the CTP scheme in Queensland, where a high percentage of claimants obtain legal representation, it was anticipated that number of claimants opting-in to the study may be reduced, therefore, 3,146 eligible claimants were initially approached for consent. The UQ SuPPORT study received ethical approval (Approval No.: 2009000035) from the Medical Research Ethics Committee at The University of Queensland, Brisbane, Australia.

Measures

Participants were assessed via Computer Assisted Telephone Interview (CATI) and paper questionnaire methods on a range of physical and psychosocial constructs at 6 (Wave 1), 12 (Wave 2) and 24 months (Wave 3) post-RTC. Each measure (listed below) was used at each wave, with the exception of demographics (Wave 1 only) and questions relating to the participant's mental health history (Wave 1 and Wave 2 only). Further information regarding each measure and the data collection procedure is available in the study protocol[21].

Interview measures

Mental health was assessed using the Composite International Diagnostic Interview module for PTSD (CIDI-PTSD)[22] and the CIDI-Short Form (CIDI-SF)[23] for Major Depressive Episode (MDE) and Generalised Anxiety Disorder (GAD), based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria[24]. Diagnoses were dichotomised as 0 (no diagnosis) and 1 (diagnosis). Perceived threat to life was also assessed by asking participants, "How much did you believe you were going to die during the accident?" Responses were categorised as 1 (not at all), 2 (slightly, moderately, or strongly), and 3 (very strongly).

Mental health history was acquired by asking participants if they had ever (1) seen a mental health professional and (2) subsequently been given a diagnosis. Participants who had received a diagnosis were coded as 1 (mental health history), all others were coded as 0 (no mental health history).

Questionnaire measures

Health related QoL was assessed using the SF-36v2[25]. This measure uses 36 questions to summarise the respondent's health in the past 4 weeks, where the respondent chooses one option (from three to five options) on each question. The 36 questions make up eight sub-scales or domains (Physical Functioning, Role Limitation because of Physical Functioning, Bodily Pain, General Perception of Health, Vitality, Social Functioning, Role Limitation because of Emotional Functioning and Mental Health). The eight scales are norm-weighted to form two constructs: the Physical Component Score (PCS) and Mental Component Score (MCS). SF-36v2 items and scales are standardized to a 0 – 100 point scale, and higher scores indicate better QoL.

Alcohol Use was assessed using the Alcohol Use Disorder Identification Test (AUDIT)[26]. The AUDIT consists of 10 positively worded items, for example, 'How often do you have a drink containing alcohol?', scored from 0 (never) to 4 (4 or more times a week). Responses were summed, and participants with a total score of eight or greater were classified as 'at risk' of an alcohol problem, and participants with a total score of seven or less were classified as 'not at risk'.

Pain level was obtained from the Örebro Musculoskeletal Pain Questionnaire (OMPQ)[27] using the pain subscale score, and ranged from 0 to 100.

Expectations regarding pain persistency and returning to work within 6 months were assessed using two individual items from the OMPQ[27]. A 10-point Likert scale was used to rate each response, with a score of eight or greater indicating a 'high expectation'.

Social support was assessed using the Multidimensional Scale of Perceived Social Support (MSPSS)[28]. The MSPSS consists of 12 positively worded items relating to support from family, friends and significant others, for example, 'There is a special person who is around when I am in need'. Each item was scored from 1 (very strongly disagree) to 7 (very strongly agree). A total social support score was calculated; the higher the score, the greater the level of perceived support.

Demographics and injury factors. Gender, age and road user type for each participant was collected. Road users were defined as vulnerable (pedestrian, cyclist) and non-vulnerable (driver, passenger). MAIC provided AIS 2005 data for each participant in April 2013 (2.5-4 years post-RTC), with this time lag ensuring all injuries had been accurately recorded. The Injury Severity Score (ISS)[29] was then calculated from the AIS data, which is a classification system for physical injuries. According to the ISS classification, an ISS of 1-3 generally includes superficial injuries such as a cervical spine strain, i.e 'whiplash', and cuts and bruises. An ISS of 4-8 includes minor injuries such as simple upper extremity long bone fractures, and an ISS of 9+ generally includes a combination of superficial and minor injuries[30], or injuries such broken ribs or lower extremity long bone fractures.

Statistical Analyses

Missing data

Missing data was estimated using mean substitution, for participants with at least 80% of data on the AUDIT, OMPQ, MSPSS, and SF-36v2 scales.

Multivariable analysis

IBM SPSS Statistics v22 (SPSS) for Windows was used for the analysis. To account for the repeated responses given by each participant over the course of the study, multilevel modelling, using the Linear Mixed Models (LMM) procedure in SPSS, was used[31]. This method allows all available information for participants with at least one value of the outcome and predictor variables to be included in the analysis. The two components of health-related QoL, PCS and MCS, were assessed separately. The relationship of both person-level (between-subject) and wave-level (within-subject) predictors with each component over time was assessed using a marginal modelling approach[31]. A first-order autoregressive covariance matrix was used for the PCS model and an unstructured covariance matrix was used for the MCS model, as these residual structures produced the best model fit with the smallest Akaike Information Criterion (AIC)[31]. The main effect of time on each of the eight SF-36 domain scores was also assessed using the same method (LMM).

Time was treated as a factor (categorical variable), and 14 predictor variables were initially tested for univariate associations with PCS and MCS, including five person-level variables (gender, age, ISS, road user type and history of mental illness) and nine wave-level variables (perceived threat to life, social support, PTSD diagnosis, MDE diagnosis, GAD diagnosis, alcohol use, expectation for pain to persist, expectation to return to work and pain level). A cut-off of $p < .10$ was used for including predictors in the initial model. Non-significant univariate predictors for PCS were gender, mental health history and alcohol use, and for MCS were gender and age. Forward selection was used, starting with the person-level variables, then adding the wave-level variables one at a time to create a main effects model. Interaction terms for each predictor with time were then added to assess any time effects, and finally, interaction terms for PTSD, MDE and GAD with each predictor were added to assess moderation effects. Maximum likelihood estimation and likelihood ratio (LR) tests were used to compare nested models[32]. A predictor/interaction was retained in the final model when the LR test and F test of the predictor/interaction had a result with $p < .05$. However, for PTSD, MDE, GAD, these predictors were retained regardless of significance in order to explore the interaction effects.

Estimated marginal means were reported for the final model, with a Šidàk adjustment[33] used for multiple comparisons when reporting 95% confidence intervals. Estimated marginal means for continuous predictors were reported at their quartile values (25^{th}, 50^{th} and 75^{th} percentile).

Results

Of the 3,146 eligible people invited to participate in the study, 382 (12%) initially consented, with all eligible participants, who had not actively dropped out, approached at each wave. Overall, 343 provided a full response on the SF-36v2 for calculating the PCS and MCS for at least one wave and are, therefore, eligible for the current analysis. The retention of participants during the UQ SuPPORT study was at least 65% at each wave[21].

Age ranged from 19-94 years (*M* = 48.63, *SD* = 14.87), and 63.0% (n = 216) of the sample were female. The majority of claimants were drivers involved in the RTC (63.8%), 16.3% were passengers, 14.3% were cyclists, and 5.5% were pedestrians. Of the 343 participants included in the analysis, 299 returned information regarding health-related QoL at Wave 1, 252 at Wave 2, and 254 at Wave 3. The majority of participants has an ISS of 1-3 (n = 224, 65.3%), with 23.6% (n = 81) having an ISS of 4-8 and 11.1% (n = 38) having an ISS of 9+. Table 1 shows participants reported lower physical (*M* = 41.1, *SD* = 10.0) and mental (*M* = 39.95, *SD* = 13.5) health-related QoL, on average across all waves, compared to levels seen in the Australian population (PCS: *M* = 49.8, *SD* = 10.3; MCS: *M* = 50.0, *SD* = 9.9)[34]._ENREF_33

Significant changes over time were seen for all domain scores: PF, F (2, 481) = 8.02, $p <$ .001; RP, F (2, 489) = 23.58, $p < .001$; BP, F (2, 490) = 23.69, $p < .001$; GH, F (2, 488) = 3.95, $p = .02$; VT, F (2, 494) = 11.37, $p < .001$; SF, F (2, 496) = 15.82, $p < .001$; RE, F (2, 490) = 6.21, $p = .002$; MH, F(2, 481) = 5.49, $p = .004$. In all cases except for General Health Perceptions (GH), these changes were in the direction of improving health-related QoL over the three waves. However, domain scores remained below, usually well below, the population mean. For GH, the scores were higher overall compared to every other domain, and dropped slightly at Wave 2 before returning to Wave 1 levels at Wave 3.

Physical health-related QoL (PCS)

A total of 324 participants had at least one value on each of the predictor variables and were included in the final multilevel model for PCS. Significant main effects on PCS score were: Time, F (2, 438) = 8.03, $p < .001$; age, F (1, 333) = 11.51, $p = .001$; pain level, F (1, 655) = 113.41, $p < .001$; expectations regarding returning to work in 6 months, F (1, 679) = 27.42, p < .001; perceived threat to life, F (2, 695) = 7.05, $p = .001$, and the presence of MDE, F (1, 572) = 5.36, $p = .021$.

Table 2 displays the adjusted mean PCS scores from the final multilevel model. Low expectations of returning to work, higher perceived threat to life and aging were associated with lower PCS scores at all waves. Participants with a low expectation to return to work reported significantly lower PCS scores than those who had a high expectation to return to work (Mean difference = 3.20; 95% CI = 2.00 – 4.40). In terms of perceived threat to life, participants who reported very high threat perceptions also reported significantly lower PCS scores when compared to participants who reported no perception of threat (Mean difference

= 3.59; 95% CI = 1.28 – 5.91) and when compared to participants who perceived some level of threat (Mean difference = 2.90; 95% CI = 0.74 – 5.07). Older age predicted lower PCS such that as age increased by one standard deviation (*SD* = 14.87), PCS score increased by 1.2 points (equivalent to 0.12 SD).

There was a significant relationship found between pain and PCS score over time. This effect was primarily focused at Wave 3, so that those with low pain levels (pain score at the 25th percentile) had significantly higher PCS scores at Wave 3 compared to Wave 1 (Mean difference = 2.18; 95% CI = 0.33 – 4.03) and compared to Wave 2 (Mean difference = 2.12; 95% CI = 0.73 – 3.51), while no effect of time was found for participants with higher pain levels (Table 2). PTSD significantly moderated the relationship between expectation of persistent pain and PCS, where a high expectation significantly predicted lower PCS scores for those without a PTSD diagnosis (Mean difference = 2.25; 95% CI = 1.20 – 3.70). The relationship between expectation of persistent pain and PCS score was not statistically significant when PTSD was present. MDE significantly moderated the relationship between pain and PCS. When pain level was low (pain score at the 25th percentile), participants with an MDE diagnosis had significantly lower PCS scores than those without an MDE diagnosis (Mean difference = 1.78; 95% CI: 0.09 – 3.48). However, when pain level was high (pain score at the 75th percentile), the presence of an MDE diagnosis had no effect on PCS scores.

Mental health-related QoL (MCS)

A total of 327 participants had at least one value on each of the predictor variables and were included in the final multilevel model for MCS. Significant main effects on MCS score were: injury severity score, F (2, 283) = 4.37, p = .014; pain level, F (1, 698) = 14.58, p < .001; social support, F (1, 610) = 30.01, p < .001; expectation to return to work in 6 months, F (1, 691) = 11.50, p = .001; presence of PTSD, F (1, 629) = 25.66, p < .001 and presence of GAD, F (1, 655) = 5.06, p = .025. Time as a main effect was not significant. Significant interactions were found between PTSD and GAD, F (1, 641) = 5.59, p = .018; PTSD and MDE, F (1, 653) = 11.65, p = .001; PTSD and pain, F (1, 655) = 8.08, p = .005 and between MDE and pain, F (1, 636) = 3.93, p = .048.

Table 3 displays the adjusted mean MCS scores from the final multilevel model. Lower injury severity, less social support and a lower expectation to return to work were associated with lower MCS scores at all waves. Participants with an ISS 1-3 reported significantly lower MCS scores than those who had an ISS 4-8 (Mean difference = 3.39; 95% CI = 0.58 – 6.21), and were not significantly different from those who had an ISS 9+ (Mean difference = 1.93; 95% CI = -1.84 – 5.69). Given this finding that the most minor injured participants report the lowest mental health-related QoL, post-hoc tests examining the influence of mental health problems, namely PTSD, on the relationship between injury severity and MCS score were conducted. These tests revealed that within the group with ISS 1-3, those with PTSD (Adjusted mean = 31.22) reported significantly lower MCS scores than those without PTSD (Adjusted mean = 37.96; Mean difference = 6.73; 95% CI = 3.94 – 9.53). For ISS 4-8, those with PTSD (Adjusted mean = 35.51) also reported significantly lower MCS scores than those without PTSD (Adjusted mean = 41.11; Mean difference = 5.60; 95% CI = 1.70 – 9.51), however, the MCS scores were not as low as those reported by participants with ISS 1-3. There was no significant difference found in those with ISS 9+.

Higher social support predicted higher MCS scores, such that as social support increased by one standard deviation (*SD* = 15.39), MCS score increased by 2.4 points (equivalent to 0.25 SD). Those with a higher expectation to return to work in 6 months had higher MCS scores (Adjusted mean = 38.23) than those with a low expectation to return to work (Adjusted mean = 35.13; Mean difference = 3.09; 95% CI = 1.30 – 4.89).

PTSD significantly moderated the relationship between GAD and MCS, where the presence of GAD predicted lower MCS scores for those with a PTSD diagnosis (Mean difference = 4.70; 95% CI = 1.52 – 7.87). The relationship between GAD and MCS score was not statistically significant when PTSD was absent. PTSD also significantly moderated the relationship between MDE and MCS, where the presence of MDE predicted lower MCS when PTSD was absent (Mean difference = 8.75; 95% CI = 6.46 – 11.05), but had no significant relationship with MCS when PTSD was present. The relationship between pain and MCS was moderated by both PTSD and MDE, such that when pain level was low (pain score at the 25^{th} percentile), participants with a PTSD diagnosis had significantly lower MCS scores than those without a PTSD diagnosis (Mean difference = 7.99; 95% CI: 5.09 – 10.90). When pain level was high (pain score at the 75^{th} percentile), participants with a PTSD diagnosis still displayed a significantly lower MCS score than those without a PTSD diagnosis (Mean difference = 3.87; 95% CI: 1.52 – 6.23, however the difference was smaller than at lower pain levels (Figure 1). In terms of the moderating effect of MDE, participants with an MDE diagnosis had significantly lower MCS scores than those without a MDE diagnosis when pain level was low (Mean difference = 3.89; 95% CI: 1.13 – 6.64). When pain level was high (pain score at the 75th percentile), participants with an MDE diagnosis still displayed a significantly lower MCS score than those without an MDE diagnosis (Mean difference = 6.66; 95% CI: 4.50 – 8.82), with this difference being larger than at lower pain levels (Figure 2).

Discussion

The aims of this study were to assess self-reported health-related QoL in a cohort of individuals injured in a road traffic related injured individuals, and to examine the impact of psychological disorders, and associated factors, on health-related QoL, including changes over the two years following injury. Examination of the SF-36 component and domain scores compared to norms indicates that all are low, at approximately one standard deviation below population norms. Overall in univariate analyses of domain specific scores, health-related QoL improved over time following injury, however, by Wave 3 (24 months), the change is in the small to moderate effect size range. This indicates a significantly poorer recovery in this cohort of injured individuals, which has also been found following non-trauma-related orthopaedic surgery[35]. Furthermore, the level of health-related QoL at Wave 3 was significantly lower than population norms, consistent with other research[7]. The possible exception was perceptions of General Health, which while below norms, was higher than the other domain scores and remained relatively stable over time. This suggests that perceptions of General Health may not be a sensitive indicator of recovery in terms of health-related QoL.

When we examined the Physical Component Score (PCS) as an indicator of overall physical health-related QoL, we found that improvement over time was only significant where pain was low. This suggests that pain is an important determinant of physical recovery and is certainly consistent with other findings in whiplash[36]. Early assessment and intervention with pain should improve physical health-related QoL in this population. Furthermore, depressive disorder was found to be related to overall physical health-related QoL through its relationship to pain. Thus, an individual who has depressive disorder and higher pain will also have lower physical function and QoL. Depression is known to be a consequence of chronic pain[37], and this finding suggests that its effect on physical function is via its relationship with pain. Of particular interest was that PTSD was also associated with lower physical health-related QoL via an association with negative expectation of recovery. PTSD is associated with negative expectations about the future in general, as the traumatic stress experience often changes the individual's sense of a safe predictable world[38]. Furthermore, PTSD is associated with avoidance of the circumstances and reminders of the original trauma. Through these negative expectations, enhanced by the presence of PTSD, the injured individual may be less motivated in physical rehabilitation and during the recovery process. Perceived threat to life was also directly associated with physical health-related QoL, and this is a precursor for PTSD. These are influences on physical recovery that can be changed through care directed at both negative expectations and avoidance within the context of psychological interventions.

In contrast to the PCS, the Mental Component Score (MCS) was found to be unrelated to time of assessment within the model we tested. Thus, the relatively small changes over time found in the univariate analyses of the individual domain scores were not reflected in the comprehensive model. Mental health-related QoL appears to be relatively stable over time and is at a level that indicates significantly lower QoL and mental health-related functioning in this predominately minor injury cohort than would be expected in the general population. This is consistent with other findings where MCS was also low[7].

Not surprsingly, lower MCS was associated with less social support, therefore mental health-related QoL is likely to be enhanced by the presence of strong support systems following injury. In contrast, the relationship between MCS and injury severity, where the most minor injuries with an ISS 1-3 had the worst mental health-realted QoL, could initially be thought of as counterintuitive. However, 79% of the current sample with an ISS 1-3 had whiplash-related injuries, and previous research has established the relationship between whiplash and mental health problems, namely PTSD[39]. Results from the current study also reflected these findings, with the lowest MCS scores seen for those with the most minor injury severity (ISS 1-3) and PTSD. The finding for injury severity and MCS is in contrast to the results for PCS, however, this is a predominately minor injury sample, and perhaps the range of injury severity was not sufficiently wide to be reflected in the PCS.

Whilst presence of an anxiety disorder or major depressive disorder are associated with lower MCS, PTSD has the strongest relationship with mental health-related QoL. Based on the analysis of the two-way interactions, the relationship between major depressive disorder and poorer mental health-related quality of life is linked with its association with higher pain, as with PCS. This suggests that PTSD and major depressive disorder have different influences on mental health-related QoL, whereas for PTSD, not only is it's relationship stronger, but also the relationship is direct without the mediation of pain, whereas major depressive disorder is via its association with pain.

Limitations

A potential limitation of the study is the relatively low percentage of claimants who opted-in to the study, likely to be a consequence of obtaining consent via post rather than in person, with previous studies that have recruited via post reporting similar response rates[12]. In fact, there has been a decline in participation rates in epidemiological research in general over a number of decades, with Steeh[40] demonstrating an increase in total non response to sample surveys in the United States during the 1960s and 1970s. Steeh suggested heightened privacy and confidentiality concerns led to the higher refusal rates[40]. Privacy concerns are still relevant today, and may have affected our participation rate, given we targeted participants seeking compensation. Despite our best efforts to affirm confidentiality, it is possible potential participants may have been so concerned about privacy that they refused participation. Concernedly, a more recent review of participation rates in epidemiological research has shown that these declines have continued to present day, and are likely to decline further in coming decades[41]. In addition, the method of recruiting eligible claimants, via a letter from MAIC, was governed by legislative requirements. Others have also found that recruiting claimants within a common law CTP scheme, where a high percentage of claimants are represented by a lawyer, results in a reduced sample; A study conducted with a similar Australian sample reported a rate of 13%, where 114 out of 859 claimants were available for analysis[42].

Due to these constraint, over 3146 eligible claimants were initially approached for consent in the current study, enabling us to analyse the long-term recovery patterns of over 343 claimants. Participants who consented were found to be older (mean age= 49 years) than those who declined to participate (mean age=40 years) and were more seriously injured (ISS of 4 or greater=35%) than those who declined to participate (ISS of 4 or greater=18%)[21]. This finding may be symptomatic of recruiting from a cohort with predominately minor injuries, given those with very minor injuries may have recovered prior to receiving the invitation letter and therefore declined to participate in the study. These differences may affect generalizability of the findings. Even though generalizability may be reduced, we would argue that the results are vitally important for our understanding of the risk factors for recovery in compensable motorists with predominately minor injuries, an arguably under-researched group. In addition, whilst we used a structured interview for diagnosis that allowed us to feasibly assess the cohort over time, the ideal method for diagnosis is via clinical interview. The accuracy of the diagnosis may have been reduced by the CIDI methodology using trained non-clinicians. Lastly, the self-report of subjective symptoms such as pain, may be exaggerated within this sample, given they are claimants within a common law system seeking financial compensation for their injury. While we don't have reason to believe, or evidence to suggest, that this is occurring within this study, we must acknowledge it as a potential source of bias.

Conclusion

Health-related QoL in individuals with predominately minor injuries from compensable motor vehicle accidents is poor, and shows little recovery over two years following injury. Lower pain is a significant moderator of improvement in physical health-related QoL. The presence of comorbid PTSD, and major depressive disorder, negatively impact on health-related QoL, either directly as in the case of PTSD on mental-health related QoL, or via greater pain or negative expectations.

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Conflict of Interest Statement

We do not have any financial or personal relationships with others that could inappropriately influence our work. We declare there are no conflicts of interest.

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Figure 1. The moderating effect of PTSD on the relationship between adjusted mean MCS scores and pain level.

Figure 2. The moderating effect of MDE on the relationship between adjusted mean MCS scores and pain level.

Table 1. Mean (SD) of the eight SF-36 domain scores and two component scores for each wave, compared to Australian Norms.

M (SD)	Australian Norms	Wave 1 (*N* = 299)	Wave 2 (*N* = 252)	Wave 3 (*N* = 254)
Physical Functioning (PF)	49.8 (10.1)	38.5 (11.3)	39.7 (11.0)	41.2 (11.5)
Role Limitation – Physical (RP)	49.9 (10.1)	35.9 (11.6)	39.1 (11.4)	41.3 (12.3)
Bodily Pain (BP)	49.9 (10.0)	35.4 (9.5)	37.4 (9.6)	40.3 (11.6)
General Perception of Health (GH)	49.9 (10.1)	45.6 (9.7)	44.8 (10.0)	45.4 (10.7)
Vitality (VT)	49.8 (10.0)	41.4 (9.9)	43.6 (10.1)	44.0 (10.7)
Social Functioning (SF)	50.0 (10.1)	37.1 (11.8)	39.7 (11.8)	41.8 (12.0)
Role Limitation – Emotional (RE)	50.0 (10.1)	33.5 (17.1)	36.3 (16.1)	38.0 (17.1)
Mental Health (MH)	50.0 (10.0)	38.7 (12.6)	41.0 (11.4)	41.3 (12.2)
Physical Component Score (PCS)	49.8 (10.3)	39.7 (9.5)	40.9 (9.7)	42.9 (10.5)
Mental Component Score (MCS)	50.0 (9.9)	38.1 (14.1)	40.6 (12.8)	41.4 (13.3)

_ENREF_33

Table 2. Adjusted mean PCS score for significant predictors, including significant interactions with time, PTSD & MDE.

Predictors			
Main Effects	Low	High	
Expectation to return to work***	37.0	40.2	
	None	Some	Very high
Perceived threat to life**	40.1	39.4	36.5
	25th percentile	50th percentile	75th percentile
Age**	39.4	38.5	37.9
Interactions with Time			
Pain level**	Wave 1	Wave 2	Wave 3
25th percentile	40.9	41.0	43.1
50th percentile	38.7	38.5	39.5
75th percentile	36.3	35.8	35.7
Interactions with PTSD			
Expectation – persistent pain**	Low	High	
PTSD = Y	38.0	37.9	
PTSD = N	40.5	38.0	
Interactions with MDE			
Pain level**	25th percentile	50th percentile	75th percentile
MDE = Y	40.8	38.5	36.2
MDE = N	42.6	39.2	35.7

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Notes: (1) Continuous predictors were age and pain level. Quartile values (25^{th}, 50^{th}, 75^{th}) were used for the evaluation of PCS score for the 324 participants included in the final model. When calculating the adjusted mean for a continuous predictor, all other continuous predictors were assessed at their average, and categorical variables were assessed at their lowest level

(2) Categorical predictors were MDE diagnosis present (Y/N), PTSD diagnosis present (Y/N), expectation to return to work (low/high), expectation for pain to become persistent (low/high) and perceived threat to life (none, some, very high).

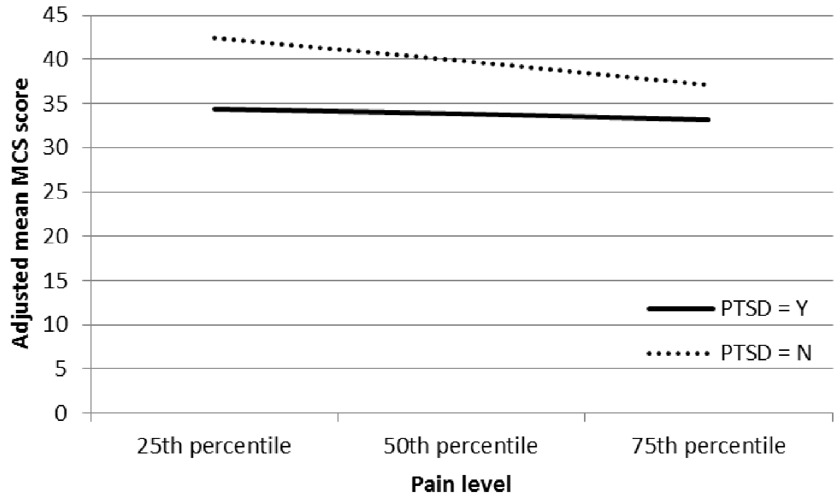
Table 3. Adjusted mean MCS score for significant predictors, including significant interactions with PTSD and MDE.

Predictors			
Main effects	ISS 1-3	ISS 4-8	ISS 9+
Injury severity*	34.9	38.3	36.8
	25th percentile	50th percentile	75th percentile
Social support***	35.6	37.1	38.4
	Low	High	
Expectation to return to work**	35.1	38.2	
Interactions with PTSD			
GAD diagnosis present*	Yes	No	
PTSD = Y	31.4	36.1	
PTSD = N	39.6	39.5	
MDE diagnosis present**	Yes	No	
PTSD = Y	32.8	34.8	
PTSD = N	35.2	44.0	
Pain level**	25th percentile	50th percentile	75th percentile
PTSD = Y	34.4	33.8	33.2
PTSD = N	42.4	39.8	37.1
Interactions with MDE			
Pain level*	25th percentile	50th percentile	75th percentile
MDE = Y	36.4	34.2	31.8
MDE = N	40.3	39.4	38.5

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Notes: (1) Continuous predictors were social support and pain level. Quartile values (25^{th}, 50^{th}, 75^{th}) were used for the evaluation of MCS score for the 327 participants included in the final model. When calculating the adjusted mean for a continuous predictor, all other continuous predictors were assessed at their average, and categorical variables were assessed at their lowest level.

(2) Categorical predictors were Injury severity (ISS 1-3, ISS 4-8, ISS 9+), MDE diagnosis present (Y/N), GAD diagnosis present (Y/N), PTSD diagnosis present (Y/N) and expectation to return to work (high/low).



Adjusted mean MCS score
45
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25th percentile
50th percentile
75th percentile
Pain level
PTSD = Y
PTSD = N

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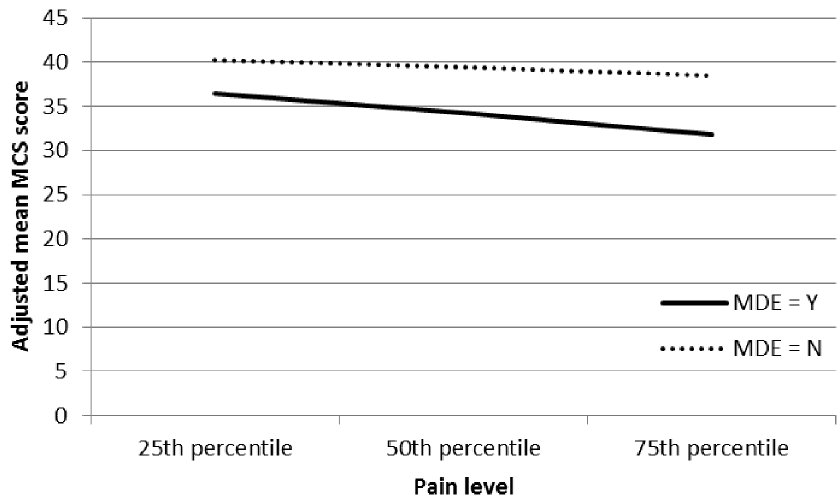
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Adjusted mean MCS score
MDE = Y
MDE = N
25th percentile
50th percentile
75th percentile
Pain level

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