The Impact of Traumatic Injury on Mental Health Outcomes

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Table of Contents

List of Tables and Figures

Study 1

Study 2

Abstract

***Objective*:** Traumatic physical injury is a leading cause of physical and psychological disability, wielding a multi-faceted impact on an individual's quality of life and a subsequent extensive global economic burden. Individuals who have experienced a traumatic injury have been shown to have elevated risk for depression, anxiety and PTSD. However, the trajectory pathways and predictors for these three outcomes within the traumatic injury population have yet to be delineated. An understanding of the risk factors and trajectory patterns for each outcome will enable greater specificity in screening for, and then clinical implementation of injury rehabilitation, both physically and psychologically. The program of research presented in this dissertation comprises three parts. First, a literature review of research investigating traumatic injury and mental health is outlined in Chapter One. The second section of the thesis comprises two subsequent chapters (Chapters Two and Three respectively) corresponding to empirical work investigating:

Study 1: A comparison of the longitudinal trajectories of depression, anxiety and PTSD symptom severity following traumatic injury, including investigation of the mediating effects of age, gender and psychiatric history on these patterns.

Study 2: The role that injury-related characteristics play in the development of depression, anxiety and PTSD symptomatology following injury, specifically the influence of injury site and severity as predictors of each mental health outcome.

***Methods*:** In a multi-site prospective longitudinal study, participants with a traumatic physical injury (N=1098) were assessed during hospital admission, and followed up at 3 months (N=932, 86%) and at 12 months (N=715, 71%). The same sample was used for both studies. Injury Site was measured using the Abbreviated Injury Scale 90 (AIS); and objective Injury Severity was measured using the Injury

Severity Score (ISS). Participants completed the Hospital Anxiety and Depression Scale (HADS), Clinician Administered PTSD Scale (CAPS) and Mini International Neuropsychiatric Interview (MINI version 5.5). Random intercept mixed modelling analyses were conducted to evaluate the research aims.

***Results*:**

Study 1: Each mental health outcome exhibited a statistically significantly different trajectory from the others, despite PTSD and depression both demonstrating a recovery pattern. Anxiety was aligned with a delayed-onset trajectory. The inclusion of socio-demographic factors did not significantly influence these trajectories.

Study 2: Injury severity was positively correlated with PTSD symptom severity, but not with anxiety or depressive symptoms. Head, face and external injuries were positively correlated with PTSD symptomatology. Lower extremity and external injuries were associated with depression. Finally, the presence of any injury, irrespective of site or severity, was associated with worse levels of each of depression, anxiety and PTSD symptomatology.

***Conclusions*:** The findings from this program of research suggest that traumatic injury has a negative impact on mental health within the initial 12-months following injury, which manifests in different trajectory patterns for depression, anxiety and PTSD symptom severity. Of particular clinical relevance is the delayed-onset pattern for anxiety, which exhibits a non-linear increase over 12 months without indicators of remission and therefore would benefit from early intervention. Additionally, recognition of factors that contribute to a poorer psychological adjustment, including sociodemographic factors and/or an injury located on an individual's head, face, lower extremity or external injury may assist with screening and subsequent interventions

aimed at mitigating not only the immediate psychological consequences; but also the overall social and economic burden that prolonged injury can cause.

Statement of Candidature

I certify that the work in this thesis entitled 'The Impact of Traumatic Injury on Mental Health Outcomes' has not previously been submitted for a higher degree to any other university or institution other than Macquarie University.

I also certify that any sources of information used throughout the thesis are acknowledged, including any help or assistance that I have received in my work and preparation of this thesis.

The research and data within this thesis was reviewed by the University of Melbourne, the Royal Melbourne Hospital and Macquarie University, reference numbers:

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Macquarie University Human Research Ethics Committee (5201100800D)

Signature _____

Katharine BAECHER (42362911)

Date _____

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Chapter One. Introduction and Thesis Overview

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1.1 Introduction

This research project will explore the effect of traumatic physical injury on mental health problems, with a particular focus on the impact of specific predictors of mental health outcome. Additionally, the project will explore the longitudinal trajectory of three different mental health outcomes following traumatic physical injury: depression, anxiety and Posttraumatic Stress Disorder (PTSD) symptomatology. This initial chapter will review and evaluate the current literature on the mental health consequences of traumatic physical injury; specifically, the impact of site of injury and severity of injury on symptoms of depression, anxiety and PTSD. In particular, the impact of these characteristics of injury in relation to mental health outcomes will be evaluated in context of existent studies in this field, inclusive of a review of methodological including design limitations. It will move towards a rationale for the current program of research; and conclude with recommendations for research directions.

1.2 Burden of Traumatic Injury

Similar to previous definitions (O'Donnell, Bryant, Creamer & Carty, 2008; Quale & Schanke, 2010), the term 'traumatic injury' in the current study refers to physical injury arising from a potentially traumatic event which is severe enough to warrant hospitalisation. Potentially traumatic events can include a motor vehicle accident, home and industrial accidents including falls, and physical assault by gun, knife or sharp object (deRoon-Cassini, Mancini, Rusch, & Bonanno, 2010). Whilst the events themselves are typically unexpected and negative, the resultant injuries can also

be severe and potentially debilitating, affecting any areas of the body which might then lead to acute and chronic impairment.

Traumatic injury is a leading cause of significant physical and psychological disability both nationally and globally (Krug, Sharma, & Lozano, 2000; Wiseman, Foster, & Curtis, 2013). Injuries have been shown to affect all population groups, irrespective of age, income or geographic location. Estimates by the World Health Organisation show that almost 16,000 people die from injuries every day, making them the leading cause of death in all groups for both sexes. It is estimated that approximately 16% of the world's burden of disease is attributable to traumatic injury (Zatzick et al., 2000). This is not surprising given that advances in injury care management and systems have led to an increase in survival rates of seriously injured people.

For every person who dies from their injuries, several thousand injured persons survive but many are left with permanent disabling sequelae (Davydow et al., 2009; Krug et al., 2000). In Australia, 10.5% of the population experiences an injury that requires admission to an emergency department every year (O'Donnell, Creamer, Pattison, & Atkin, 2004), whilst in the USA, over two million people per year are hospitalised on account of their traumatic injuries (Bryant, 2011).

1.3 Impact of Traumatic Injury

Traumatic injury has a multi-faceted impact on physical integrity and health, and can contribute to changes in employment capability and subsequent financial status. The personal effect on the individual has been shown to be extensive and can inhibit all aspects of a person's physical functioning, including sexual capacity, fatigue

levels and capability to engage and fulfil activities of daily life (Wiseman et al., 2013). These effects have then been shown to negatively impact quality of life in both the short and long-term (Holbrook, Hoyt, & Anderson, 2001; Sluys, Haggmark, & Iselius, 2005).

Traumatic injury has also been linked with a range of mental health problems associated with changes in physical health functioning. A population-based matched cohort study by Cameron, Purdie, Kliwer and McClure (2006) found statistically significant differences in mental health service engagement over 10 years between injured and non-injured groups of individuals. Even after adjusting for co-morbidities and pre-existing mental health claims, their results indicated that the injured cohort had 3.24 times the rate of mental-health related hospitalisations and 1.53 times the number of mental health-related physician claims when compared to the non-injured cohort. This highlights the presence of a longer term negative impact of traumatic injury on general mental health outcome, even years after the event.

Cameron et al.'s (2006) results are consistent with burgeoning research that has continued to demonstrate reduced psychological functioning after traumatic injury (Sorberg, Bautz-Holter, Roise, & Finset, 2010; Woolrich, Kennedy, & Tasiemski, 2006). Such research has shown that after traumatic injury, individuals are at particular risk for anxiety, depressive and posttraumatic stress syndromes (Bryant, 2011). O'Donnell et al. (2004) found that over 20% of injury survivors met criteria for at least one psychiatric diagnosis at 12 months post-injury. However, there is notable disparity in mental health prevalence rates and types of mental health outcome in the available research literature. This disparity is largely attributed to methodological limitations and inconsistencies across the various studies (O'Donnell et al., 2008), as well as the

complex nature of the traumatically injured population group. This complexity stems from the heterogeneity of causes and mechanisms of injuries that individuals within the population have experienced, as well as the influence of a range of pre-morbid, socio-demographic and cultural factors (Steel, Dunlavy, Stillman & Page, 2011).

1.4 Traumatic Injury and Mental Health in Context

Despite the volume of research in the traumatic injury domain, to date there exists only one published review paper which has synthesised the research on the relationship between mental health and traumatic injury. Wiseman et al. (2013) conducted an integrative literature review which evaluated and summarised the existing work on the prevalence of anxiety, depression and posttraumatic stress following traumatic injury; and explored the subjective experiences of traumatic injury. The integrative style of the review, which included studies that implemented a diverse range of methodologies was selected by the authors based upon the perceived complexity of the relationship between traumatic injury and mental health. Whilst this type of review can be useful for summarising past empirical and theoretical literature on a particular topic, it has been critiqued for potential bias and a lack of rigour (Whittemore & Knafl, 2005). However, given this article is the only published review to date which specifically examines the relationship between traumatic injury and mental health, the findings from the review can facilitate the direction of future research in this field - knowledge that is likely to be very valuable for this area.

Wiseman et al.'s (2013) review identified 41 studies that met their inclusion criteria. This inclusion criteria comprised primarily English language, quantitative and/or qualitative published studies on aspects of mental health by participants (16 years and over) with admission to hospital for traumatic physical injury from 1995-

2010. Included papers were then grouped into five main categories: Acute Stress Disorder (ASD) and physical injury, PTSD and physical injury, anxiety and physical injury, depression and physical injury, and subjective experiences of physical injury. Of their identified papers, 35 used quantitative methods (purposive cohort designs, descriptive follow-up designs, prospective randomised longitudinal designs and randomised controlled trials). The remaining papers included mixed method studies and qualitative studies. Based on their review, the authors concluded that PTSD, depression and anxiety were frequent sequelae associated with traumatic injury. Specifically, PTSD was the most frequently investigated mental health problem associated with traumatic injury, with prevalence rates ranging from 30 to 93%. This highly variable range in prevalence rates appears to be reflective of methodological constraints from the use of the integrative review style such that included studies compared and clustered together comprised different study designs, outcome measures (e.g., 'psychological distress', 'psychological disability' PTSD symptoms and/or caseness), and highly variable assessment time points (e.g., 3 months vs. 12 months after injury).

Comparable methodological constraints were also evident in Wiseman et al.'s (2013) review of depression associated with traumatic injury, where prevalence rates were observed to range between 28 and 42%. However, only 12 of the 41 reviewed papers explored depression as a direct effect of traumatic injury and only one of these evaluated depression as a stand-alone outcome. The authors therefore concluded that depression associated with traumatic injury has been studied on a limited level, however, the included papers can still provide guidance regarding predictors of depression after traumatic injury; variables such as age, gender, and pre-existing

psychological history, which would both extend and direct current knowledge within the domain.

Wiseman et al.'s (2013) review also emphasises the association between traumatic injury and anxiety. The operationalisation of anxiety within the integrative review is as an umbrella term that encapsulates anxiety disorders (Generalised Anxiety Disorder [GAD], Specific Phobia [travel anxiety]) and sub-threshold anxiety symptomatology. The prevalence of anxiety was found to range between 16 to 40%, again reflective of the diversity of study designs, timing of assessments, outcome measures, and method of assessment (i.e., self-report vs. clinical assessment). Again, there was no evaluation of predictor variables that might impact outcomes, hence the comparability between studies and subsequent confidence in results, is limited.

Wiseman et al.'s (2013) review is a useful paper for providing an informational summary of the research to date. However, its rigour is limited by its methodology and its lack of evaluative processes of included papers. In particular, a detailed review of the included papers revealed a number of additional weaknesses. For example, whilst Wiseman et al. (2013) purported to focus on four main areas of psychopathology (acute stress disorder, anxiety, depression and PTSD), at least two of the included studies did not address either specific or broad psychological wellbeing. Rather, a retrospective cohort study by Amstadter and Vernon (2008) that Wiseman et al. (2013) suggested alluded to the frequency of depression in comparison to PTSD, did not actually include any measures of psychopathology beyond one question on 'sadness'. Similarly, their supposition of 'quality of life' measures from two further studies (one retrospective cohort study by Sluys et al., 2005; and a prospective longitudinal study by Holbrook et al., 2001) under the umbrella of PTSD, raised caution about both the quality of included studies and the meaning attributed to the outcomes. In turn, this limits the

validity of Wiseman et al.'s (2013) inferences. There are a number of more specific areas within the traumatic injury domain that have not been included in the study, such as predictors and correlates of specific mental health outcomes (for example, pain, severity of injury and location or site of injury). Given that to date there are no reviews of these more specific areas, and that Wiseman et al.'s review did not evaluate such factors, these predictors of mental health outcome after traumatic injury are likely to be valuable contributors to the overall literature in the area.

From a recurring theme identified within Wiseman et al.'s (2013) review, it is evident that that depression, anxiety and PTSD have often been inadequately identified and treated in the acute hospital phase in Australia. Irrespective of the noted methodological constraints within Wiseman et al.'s review, the volume of studies that emphasised a subsequent need for screening and early intervention post-injury, reflects the overall economic, social and emotional burden of traumatic injury and in this way, provides a strong rationale for continuing to evaluate and improve both research and clinical practices within this domain.

Methodological Considerations in the Traumatic Injury Literature

1.5.1 Timing of Assessments

The methodological limitations raised by, and evident throughout, Wiseman et al.'s (2013) review are frequently exhibited across the traumatic injury literature. These considerations include the timing of the assessment of symptomatology after injury. Convergent evidence has demonstrated that different rates of depression and PTSD can be observed depending on the time elapsed since the injury (O'Donnell, Creamer, Bryant, Schnyder, & Shalev. 2003; Steel et al., 2011). Within the traumatic injury literature, timing of assessment has been highly variable and/or includes a wide range

within assessment points, such as comparing the outcomes of individuals who experienced trauma in recent months with those who experienced it several years earlier (O'Donnell et al., 2003; Starr et al., 2004). If time intervals are too wide, particularly in longitudinal designs, important fluctuation points in symptom severity may be masked or neutralised (King et al., 2006). The disparity in time intervals both between and within studies has been subsequently found to obscure accurate prevalence rates and potentially result in predictor inconsistencies (Ozer, Best, Lipsey, & Weiss, 2003).

1.5.2 Operationalisation of Outcome

The operationalisation and clear identification of outcomes is another disparity between studies in the traumatic injury literature. Few studies directly evaluated specific mental health diagnoses. Rather, the reviewed studies included examination of 'functional outcome, or 'quality of life' (Holbrook et al., 1998; Holtslag et al., 2007b; Read et al., 2004; Vles et al., 2005); whilst other studies varied between 'diagnosis' and 'symptomatology' (Ozer et al., 2003). Others still, focused on broad trajectories rather than specific domains (Bonanno, Kennedy, Galatzer-Levy, Lude, & Elfstrom, 2012; Brewin, Andrews, & Valentine, 2000; deRoon-Cassini et al., 2010). Lastly, the delineation of current versus lifetime diagnosis of specific outcomes was often unclear or not reported (Brewin et al., 2000). Notwithstanding the fact that each of the above operationalisations might be able to be broadly classified under 'mental health', the breadth of the definitions reduces comparability between studies and therefore inhibits generalisability of results.

1.5.3 Type of Measures

The type of measures used within each study design are important considerations in evaluating reliability, validity and clinical utility of the results. Self-report instruments are a commonly implemented measurement tools for their brevity, ease of administration and accessibility. Results from self-report measures that assess levels of symptomatology, such as the Hospital Anxiety and Depression Scale (HADS; Zigmund & Snaith, 1983), Impact of Events Scale (IES; Horowitz, Wilner & Alvarez, 1979) and General Health Questionnaire-28 Items (GHQ-28; Goldberg, 1978), are commonly used in traumatic injury research and are often used in place of clinical interviews despite their limited diagnostic interpretability (Mason, Turpin, Woods, Wardrope, & Rowlands, 2002). An overreliance on self-report measures without adjunct clinical interviews can potentially result in suggestive or inaccurate generalisations (Steel et al., 2011), particularly if the operationalisation of outcome is not clearly defined. Even within the usage of specific self-report measures, differing thresholds of caseness have been observed between studies which again serves to confuse comparability of results (Blaszczynski et al., 1998). However, when the distinction between symptomatology and caseness is acknowledged throughout the design, the utility of both symptom and/or diagnostic measures can remain valid (Ozer et al., 2003), albeit with caution recommended in the comparability of results between studies.

Mental Health Outcome and Traumatic Injury

1.6.1 Depression and Traumatic Injury

Despite depression being one of the two most commonly researched psychological sequelae post injury, Wiseman et al.'s (2013) review acknowledged a scarcity of depression-specific studies with regard to traumatic injury. When assessed

during hospitalisation shortly after traumatic injury, prevalence rates for depression varied between 8 to 60% (Bryant et al., 2010; Mason et al., 2002; Richmond et al., 2010; Steel et al., 2011), with more longitudinal studies finding rates of depression to range between 6 to 42% at 6 to 12 months after the injury has occurred (Bryant, 2011; O'Donnell et al., 2004; Steel et al., 2011; Varney, Martzke, & Roberts, 1987). Woolrich et al. (2006) conducted a longitudinal cohort study of depression levels in 963 spinal cord injury survivors up to (a mean of) 19 years after their accident. They found that 21% of their sample reported depressive symptoms at 'response time', a period which ranged between 2 to 52 years since the accident. Notwithstanding the long-term outlook of the study, the nature of the sample was skewed as it contained a purely outpatient population compromised of 80% males. This restricted population infers the exclusion of people with recent injuries and thereby potentially leads to a cohort effect. In addition, the response rate for Woolrich et al.'s (2006) study was only 50%, a further example of the design and methodological concerns evident throughout the injury and depression literature.

Notwithstanding these methodological limitations, a body of work continues to demonstrate well-established predictors of mental health (generally), and more specifically depression following traumatic injury (Steel et al., 2011). These include female gender and concomitant brain injury (Holbrook et al., 2001; Steel et al., 2011); and additionally, although not specific to depression, younger age, shorter duration between injury and assessment, pain and limited social support (Ouellet, Sirois, & Lavoie, 2009). Depression has also been shown to be associated with poorer coping mechanisms (Van Horn, 2009), increased risk of substance use and other mental health problems such as PTSD and anxiety (Wiseman et al., 2013) following traumatic injury.

Whereas there is an abundance of evidence supporting these predictors, less is known about the impact of specific objective characteristics on depression, in particular, the impact site and severity of injury as predictors of depression.

Holstag, van Beeck, Lindeman and Leenan (2007) conducted a prospective cohort study exploring the impact of injury site with depression and anxiety. Of their population of 335 injury survivors, 28% of the sample experienced a new onset of depressive symptoms between 12 to 18 months after injury. In addition, the authors found that injury site, specifically spinal cord injury, lower extremity injury or brain injury was associated with a lower quality of life and functional utility. Due to the study's cross-sectional design however, the authors were not able to infer causation in the relationship between these sites and depressive symptoms. Although this study demonstrated some encouraging outcomes regarding site as a predictor of depression, a number of methodological shortcomings limit the generalisability of results. These include the broad assessment timing range (12 to 18 months post injury), potential cohort effect with no baseline measures to afford an understanding of changes over time, and the reliance on self-report and non-specific mental health outcome measures (i.e., symptoms, rather than caseness). In spite of these limitations, the study provides a preliminary overview of the impact of injury on mental health outcomes. However, it provides little breadth to an understanding of the impact of site and severity of injury on a broader sample of the traumatic injury population. As a result, the understanding of these factors on depression over a longitudinal course of time, generalisable to a wider traumatically injured population, still remains largely unclear and would benefit from being explored within a single large-scale study.

1.6.2 Anxiety and Traumatic Injury

There is notably less literature available on non-PTSD anxiety disorders following traumatic injury when compared to either depression or PTSD (Wiseman et al., 2013). The incidence of anxiety following traumatic injury that has been explored in the literature ranges from 16 to 40% (Horner, Selassie, Lineberry, Fergusson, & Labbate, 2008; Joy, Probert, Bisson, & Shepherd, 2000; Mayou & Bryant 2002; Mayou & Bryant 2003; Woolrich et al., 2006). Some studies (Joy et al., 2000; Mayou & Bryant 2002) have found the prevalence of anxiety to be higher than the prevalence of depression, which concurs with Bryant et al.'s (2010) detailed identification and breakdown of specific anxiety disorders diagnosed 12 months after traumatic injury: generalised anxiety disorder (11.1%); agoraphobia (9.7%); social phobia (6.9%); panic disorder (5.9%) and obsessive-compulsive disorder (3.5%), totalling 37.1% of the sample and in comparison to the incidence of depression within the same group at 16.3%.

Comparable to the depression studies in this field, the range of prevalence in studies is reflective of the different operationalisations of anxiety (as symptomatology or as a disorder); the measures utilised (such as self-report screens or clinician structured interviews); and the time elapsed since injury. As a result, a clear picture of anxiety after traumatic injury is difficult to derive from the current literature. Notwithstanding the unclear prevalence, there are limited published studies that have examined symptom profiles of variables predicting anxiety patterns in the 12 months after injury. This combination of mixed prevalence studies and limited trajectory studies means that the symptom profile of anxiety following traumatic injury is difficult to identify. Furthermore, from the limited number of anxiety related studies, the most common population that has been assessed is adult survivors of motor vehicle

accidents (MVAs); this limits generalisability to other injury-related populations. For example, Mayou, Bryant and Ehlers (2001) conducted a prospective longitudinal study of 1148 participants exploring a range of psychiatric outcomes including GAD and phobic travel anxiety at 3 months and 12 months following a MVA. Anxiety symptoms were reported in 17% of their sample at 3 months, and 19% of their sample at 12 months after injury. The methodological considerations in Mayou et al.'s (2001) study that necessitate caution in interpretation of results include a high drop-out rate, overrepresentation of women and sole reliance on self-report measure. Mayou subsequently conducted follow-up studies with Bryant (2002 and 2003) with 507 patients from the original data set and identified a similar prevalence rate (16%) to the 12 months study. The prevalence pattern of anxiety identified throughout this longitudinal study (which is broken into three investigations over the course of three years), indicates that the presence of anxiety remains relatively constant. This is one of few investigations that demonstrates a more longitudinal pattern of mental health outcome after traumatic injury, and therefore despite its methodological limitations, it provides encouraging information into the pattern or impact on mental health outcomes following injury, which is the focus of the current research project.

Wiseman et al.'s (2013) review identified only 10 out of 41 papers that investigated anxiety in the context of traumatic injury; and each of those 10 papers included measures of anxiety in conjunction with either PTSD and/or depression. Asides from Wiseman et al.'s (2013) review, there have been no other published reviews that covered anxiety and traumatic injury, and none which focus on injury site and severity as predictors of outcome - which serves to further emphasise the paucity of studies in this domain. In Wiseman et al.'s (2013) review, beyond prevalence data,

there were included no papers that directly evaluated the specific impact of traumatic injury on anxiety specifically; nor were there any that examined the direct effect of predictors such as site and severity of injury, on anxiety. For example, Islam, Ahmed, Walton, Dinan and Hoffman (2010) conducted a comparative cohort study evaluating the prevalence of anxiety and depression in a group of traumatically-injured patients requiring facial surgery. They reported a prevalence rate of 20% for both depression and anxiety respectively, and observed that the traumatically injured facial group revealed a nine-fold rise in depression and a two-fold rise in anxiety in comparison to their elective control-group counterparts. Similarly to Cameron et al.'s (2006) study and Woolrich et al.'s (2006) work, this study highlights that a relationship between anxiety and traumatic injury exists; and in this case demonstrates the pattern with a sample based on a particular body site. Whilst this is an encouraging foray into the injury site domain, the nature of the study does not allow delineation between the impact of facial versus non-facial injury and therefore does not provide any further information about site, in this case, face, as a specific predictor of anxiety or depression.

1.6.3 Posttraumatic Stress Disorder (PTSD) and Traumatic Injury

PTSD is the most frequently investigated mental health outcome following traumatic injury (Wiseman et al., 2013). The prevalence of PTSD in the adult population of the United States of America has been estimated to range between 3.5 and 8% (Steel et al., 2011; Wiseman et al., 2013). In contrast, the incidence of PTSD following traumatic injury is estimated to be in the range of 18 to 42% between 1 and 6 months post-injury; and 2 to 36% at 12 months post-injury (Davydow et al., 2009; O'Donnell et al., 2003; Starr et al., 2004). Again, this prevalence range is likely

reflective of design differences, including studies focusing on PTSD symptoms versus diagnostic caseness. The PTSD and traumatic injury literature incorporates both posttraumatic stress symptoms, as well as the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition – TR, (American Psychiatric Association, 2000; DSM-IV-TR) defined PTSD. Ozer et al. (2003) conducted a meta-analysis on predictors of PTSD and symptoms in adults and established that, irrespective of the use of symptomatology or diagnostic caseness, the effect sizes in the wider field remained generally consistent. Their results concurred with those of Brewin et al.'s (2000) meta-analysis, leading them to conclude that both measurement standards provide similar validity, so long as the specific operationalization is acknowledged.

PTSD has been regularly shown to have long-term, detrimental effects on the recovery of survivors of traumatic injury. It has been correlated with an increased risk of not returning to pre-injury employment, a reduced capacity to undertake activities of daily life, and an increased likelihood of engaging in poorer, maladaptive coping mechanisms such as substance abuse (Zatzick et al., 2008). These factors have, in turn, been associated with a decreased quality of life and physical and emotional wellbeing in the context of traumatic injury (Holbrook et al., 2001). They are also concordantly associated with anxiety and depressive symptoms (O'Donnell et al., 2004; Zatzick et al., 2008).

Extensive research has outlined three main groups of predictor characteristics for PTSD: demographic variables, injury-related characteristics and psychological characteristics (Ozer et al., 2003; Zatzick et al., 2002). Predictive demographic variables include female gender, younger age, lower income, limited social support and pre-injury trauma (Steel et al., 2011). Psychological characteristics that have predicted

severity of PTSD following injury include co-morbidity, peri-traumatic dissociation and level of distress, perceived threat, and pre-morbid and/or familial psychiatric history. Less research, however, has focused on the objective injury characteristics as predictors of PTSD. Injury severity (categorised as an injury-related predictor) has revealed mixed findings in its relationship with PTSD following traumatic injury. For example, Starr et al. (2004) conducted a prospective study of 580 orthopaedic patients (following traumatic injury) and reported that 51% of the sample met criteria for a diagnosis of PTSD. There were also frequent reports of negative changes in quality of life, high levels of pain, substance misuse and behavioural avoidance of factors related to the precipitating event. The authors claimed that the occurrence of PTSD in the context of traumatic injury was not contingent on the severity or mechanism of injury. Limitations within the design make it difficult to generalise the study findings or to accurately determine the prevalence of PTSD, noting that the authors used self-report questionnaires in a diagnostic function without any additional clinical interviews. Furthermore, the time elapsed since injury ranged from two days to 64 years, the former of which is diagnostically inappropriate. The authors acknowledged a potentially biased, selective sample, with no control group, and an inability to explore change in symptomatology over time due to the inclusion of only one assessment time point. So, whilst this study provided exploration cross-sectional evaluation of PTSD and traumatic injury, the design does not allow for an examination of the impact of site of injury in relation to PTSD and other mental health outcomes, notably depression and anxiety.

Grieger et al. (2006) conducted a study which examined the prevalence rates, predictors and the course of probable PTSD and depression among seriously injured

soldiers during and after hospitalisation. Their study design exhibited a number of strengths, including a large sample size (n = 613), multiple assessments points (1, 4 and 7 months after injury) and the inclusion of injury severity as a potential predictor of outcome. They observed an increase in the prevalence of both depression and PTSD over time, and an association between the severity of the injury (at time of injury) and PTSD at one month; as well as an association between injury severity and depression severity at seven months. Notwithstanding that the results are based on a homogenous sample comprised of predominantly male soldiers with combat-related injuries, the study is a preliminary demonstration of the general pattern of PTSD and medium-term impact of untreated symptomatology. Whilst this is an encouraging foray into an understanding of the pattern of PTSD, and indeed an indicator of the ongoing burden of untreated symptomatology, the cross-sectional design with some limited longitudinal measures does not allow for a demonstration of the ways in which the trajectory develops or changes across the seven months.

An earlier longitudinal study of 101 traumatically injured patients conducted by Zatzick et al. (2002) explored the relationships of PTSD and depressive symptomatology with, injury characteristics (including severity) and demographic components (age and gender) over the course of 12 months following traumatic injury. This study is one of few that has directly explored predictors of PTSD following traumatic injury in adults. Findings suggested that initial PTSD symptomatology, prior trauma, stimulant intoxication and female gender were associated with higher symptom levels at each time point, however, severity of injury was not associated with elevated PTSD symptoms. This study also provides some important data regarding the impact of traumatic injury on PTSD; however, the literature regarding predictors following

traumatic injury can be further developed by examining a number of potential objective injury characteristics (including site of injury as well as severity of injury) for their role or association with the incidence of PTSD. The impact of such characteristics needs to be considered in our understanding of mental health outcomes following traumatic injury, such that we can then develop and implement appropriate screening tools and ultimately, guide treatment intervention.

Injury-Related Predictors of Mental Health Outcomes

1.7.1 Known Risk Factors for Injury-Related Mental Health in Adults

To date, there is one published review on the risk factors for poor mental health following injury in adults. Sareen, Erickson, Medved, Asmundson, Enna, Stein et al. (2013) summarised the physical, psychological and social risk factors for mental health concerns following injury, through the lens of Engel's (1981) biopsychosocial framework; delineating the factors into pre-injury, peri-injury and post-injury contributors. They noted female gender, genetic contribution, type or mechanism of injury (such as burn injury), the presence of TBI and/or inflammatory response, high heart rate, perceived pain and intensive care admission as biological vulnerabilities. They reported a psychiatric history, personality components, fear of death, peritraumatic dissociation, acute stress symptoms and posttraumatic adjustments as psychological correlates of poor mental health outcomes. Finally, they reported previous sexual trauma, low income, death or concurrent injury of another personnel during the incident, litigation and financial problems and poor social support, as social risk factors. Interestingly, the authors did not report upon, nor include studies that focused on injury characteristics. The exclusion of these components from the review highlights a lack of available information regarding the impact that objective

characteristics – such as site and severity of injury – have on mental health outcomes. Indeed the authors report that injury-specific research is lacking and its knowledge would provide benefit in assessing and identifying risk and resiliency factors with greater precision and thereby guide intervention and reduce the burden of injury.

1.7.2 Injury Site

To date, the site or body region of an injury appears to have been a scarcely researched predictor of mental health outcome. Of those studies that have included site in their research questions, only two were identified to incorporate a comparison of multiple sites (Haagsma et al., 2012; Holtslag, Post, Lindeman, & Van der Werken, 2007). Other studies used a specific site in their study design, such as a population group made up of spinal cord injury (SCI) victims (Vles et al., 2005) or of individuals with a facial injury (Fukunishi, 1999; Madianos, Papaghelis, Ionnovich, & Dafni, 2001). Whilst an understanding of the impact of specific sites on separate mental health outcomes following injury is useful insofar as it can assist treatment for specific populations; determining the role that each – or any – site plays in the development of a variety of mental health outcomes would enable a better theoretical comprehension of the mechanisms of mental health outcome development; as well as facilitating the development of appropriate intervention. Even a demonstration that the site of injury has little or no impact on the development of mental health outcome would extend the current literature and continue to finesse the clinical treatment practices by reinforcing the focus of predictors towards non-injury related characteristics. As such, the investigation of a comparison of the impact of multiples sites on multiple mental health outcomes in a single study is warranted.

The few identified studies show some preliminary consistency of particular sites affecting functioning and/or mental health outcome. Extremity injury has been implicated in reduced psychosocial outcome and quality of life after traumatic injury (Haagsma et al., 2012; Holbrook et al., 1998; Holtslag et al., 2007a; Holtslag et al., 2007b; Read et al., 2004). This has been attributed to the changed mobility of the patient, his or her ability to return to work, cognitive and behavioural functioning and extensive rehabilitation required for treatment (Read et al., 2004). Whilst the negative impact of traumatic injury has been demonstrated consistently, few studies have directly investigated discrete mental health as their outcome measure. Haagsma et al. (2012) conducted a prospective cohort study that assessed the prevalence rate and indicators of probable PTSD at 1 and 2 year intervals after traumatic injury. Using a sample of 332 major trauma patients, the authors found that an injury of the extremities was a strong predictor of PTSD at 2-year follow-up. However, caution in the generalisability of this result is warranted, due to the potentially confounding inclusion of traumatically brain injured (TBI)-patients, predominantly female sample and restricted cohort of 'very seriously injured' patients (operationalised as an Injury Severity Score [Baker and O'Neill, 1976; ISS] of 16 or above).

Spinal injury has also been linked with poor 'functional outcomes' (Holtslag et al., 2007b; Vles et al., 2005). Functional outcome was operationalised by Vles et al., (2005) as a health status score derived from the EuroQuol-5D (Brooks, 1996) based on mobility, self-care, daily activities, pain, anxiety and depression. Holtslag et al. (2007b) conducted a prospective cohort study of major trauma victims (defined in the study as having an ISS of 16 or above) that explored the relationship between functional health status, and personal and injury characteristics. Functional status was operationalised

within the study using the Sickness Impact Profile (SIP; Bergner, Bobbitt, Carter & Gilson, 1981) which measures limitations in the performance of everyday activities due to health problems. Encouragingly, the study compared a number of different sites of injury that included chest, abdomen, spinal cord, and lower and upper extremity. The authors established that spinal cord and extremity injury are associated with 'worse psychosocial outcome' (defined within the study by using a subcategory of the SIP consisting of alertness behaviour, social interaction, emotional behaviour and communication). Again, this does not afford an understanding of the impact on specific mental health outcomes.

Facial injury has been one of the more frequently researched sites. Studies suggest that facial injury is predictive of PTSD; and that permanent disfigurement, inclusive of facial cosmetic disfigurement (Fukunishi, 1999; Madianos et al., 2001) is more likely to lead to PTSD than depression, as well as showing a five-fold greater chance of developing any psychiatric symptomatology when compared to non-disfiguring facial injuries. Both studies purport their results to indicate that disfigurement (operationalised within their study as the presence of facial burns and cosmetic status inclusive of atrophy and scarring), rather than a specific site, is the mediating factor implicated in the outcome. This assertion has been reinforced through subsequent studies (Glynn, Shetty, & Dent, 2010; Islam et al., 2010) that have also linked facial disfigurement following traumatic injury to an increase in depression and anxiety. Besides facial, extremity and spinal injury, there appears to be little consistency in research regarding other sites, and more importantly, there is a notable paucity of studies comparing the impact of one injury site against another. In this way, a study inclusive of additional sites, such as neck, thorax and abdomen is warranted in

order to extend our understanding of the significance that injury site holds in determining mental health outcome.

It is evident through the aforementioned studies within the site of injury literature that a methodologically complicating factor is differences in the operationalisation and/or definition of outcome measurement. Noting that there is already a limited number of studies exploring site of injury and its outcome on mental health, the inclusive use of 'functional health/limitation' (Holbrook et al., 1998; Holtslag et al., 2007b; Read et al., 2004; Vles et al., 2005), 'psychosocial impairment' (Glynn et al., 2010; Madianos et al., 2001) or measures of 'quality of life' (Holtslag et al., 2007b; Madianos et al., 2001) under the auspices of mental health outcome do not facilitate an understanding of the discrete impacts on individual mental health outcomes following injury. Thus, the conduct of a large longitudinal study incorporating a comparison of multiple different sites of injury, and focusing specifically on a variety – and therefore comparison – of individual mental health outcomes, would enable an extension and valuable contribution to our knowledge of predictors of, and outcomes for, the traumatic injury domain.

1.7.3 Injury Presence and Severity

Some studies have examined the differences in mental health symptomatology between individuals who were exposed to a traumatic event through which they were injured; compared with individuals who were exposed to a traumatic event but did not sustain physical injuries (Bernat, Ronfeldt, Calhoun, & Arias, 1998; Koren et al., 2005; Perrin et al., 1996). These have ascertained that presence of injury is a more reliable and consistent predictor of psychological symptoms, than the severity of injury (whose research has demonstrated mixed findings).

For example, Koren et al. (2005) compared 60 injured soldiers with 40 non-injured soldiers who had all participated in the same combat situations. They found that 16.1% of the injured soldiers (as compared to only 2.5% of the non-injured soldiers) met diagnostic criteria for PTSD at the time of assessment, and that wounded participants reported significantly higher scores on all mental health measures (including anxiety, depression and dissociative symptoms as well as PTSD). The results also demonstrated that the presence of PTSD was not related to the severity of injuries or the severity of the traumatic event. Their results aligned with Bernat et al. (1998) and Perrin et al. (1996), who also reported that the presence of any injury, rather than the extent of a specific injury, determines mental health symptomatology (in this case, PTSD symptomatology).

Research examining the extent to which injury severity is associated with mental health outcome has produced mixed results. This may be partly due to differences in the ways injury severity is assessed. Injury severity is most commonly measured by the Injury Severity Score (ISS; Baker & O'Neill, 1976) which was developed out of the Abbreviated Injury Score (AIS; Baker, O'Neill, Haddon, & Long, 1974). The AIS pertains primarily to individual injuries and as a result, has been found to inhibit accuracy in understanding the association of multiple injuries in different body regions with mortality. In its original form, the AIS scale combined severity and outcome which meant that different ratings could be assigned to similar injuries dependent on whether and when death occurred. These noted shortfalls led to the subsequent development of the ISS, in an attempt to primarily address the multiple injury limitation of the AIS. In order to compute the ISS, the body is divided into six

areas (face, chest, abdomen/pelvis, head/neck, extremities and external) and the extent of injury to each area is scored along a 6-point ordinal scale. The three most severely injured body areas have their coded scores summed and squared to compute the ISS. The ISS maintained the strong statistical validity established by the AIS (Bull, 1954; Semmlow & Cone, 1976) and improved the statistical correlation between the severity of the injury and mortality where the ISS explained 49% of the variance in mortality to measure severity, compared to 25% using only the highest AIS grade (Baker et al., 1974).

The ISS has also shown mixed utility in research (Mason, Turpin, Woods, Wardrope & Rowlands, 2006; Quale et al., 2010). It has been used effectively in evaluating the quality of trauma care and controlling for case mix statistical analysis in trauma research (Lavoie, Moore, LeSage, Liberman, & Sampalis, 2004); however its clinical utility and appropriateness has been questioned as it does not account for differing severity of injuries in different body regions. Rather, it has been criticised for considering only one injury in each body region, which can result in some injuries being overlooked in favour of less serious injuries that occur in other body regions – thus more serious injuries being frequently overlooked in the calculation of overall ISS score calculation, in favour of less serious ones in the same body region (Osler, Baker, & Long, 1997). Yet despite these limitations, and its subsequent low predictive capacity for psychopathology (Quale et al., 2010), its primary use as a medical anatomical injury severity indicator has led to the ISS being consistently included in mental health research.

As noted, there has been mixed evidence in studies evaluating the severity of injury with mental health outcome. On the one hand, much research has demonstrated a

poor correlation between objective injury severity as measured by the ISS, and different mental health outcomes inclusive of PTSD (Holbrook et al., 2001; Koren, Arnon, & Klein, 1999; Kreis et al., 2011; Mason et al., 2006; Michaels et al., 1999; Schnyder, Moergeli, Trentz, Klaghofer, & Buddeberg, 2001; Zatzick et al., 2002), anxiety (Joy et al., 2000; Mason et al., 2006) and depression:(Joy et al., 2000; Mason et al., 2006). For example, Harris, Young, Rae, Jalaludin and Solomon (2008) examined the relationship between injury severity (using ISS, admission into the Intensive Care Unit [ICU], days in ICU and the presence of head injury as possible severity measures) and PTSD after major traumatic injury in 355 patients. They determined that PTSD was not related to injury severity using any of their severity measures, including the ISS. However, the study group was limited to patients with 'major physical trauma' (defined as having an ISS of 16 or above) represents a restricted sample and constrains our knowledge of the overall impact of injury severity. Similarly, Quale, Schanke, Froslie and Roise (2009) conducted a study with severely injured patients utilising a variety of severity measures. These measures included both the ISS and the New Injury Severity Score (NISS; Lavoie et al., 2004) which facilitated an investigation of the relationship between PTSD, anxiety and depressive symptoms and injury severity. Whilst their use of self-report questionnaires can be viewed as a limitation, and the potential of head injury patients with TBI to have confounded results, the study showed that neither the ISS nor NISS scores exhibited a positive correlation with the extent of mental health outcome symptomatology.

Conversely, research has also shown that measuring objective injury severity by means other than the ISS yields opposite results; demonstrating that severity is indeed correlated with mental health outcome, and extending this result further by

demonstrating a bidirectional relationship (Blanchard et al., 1996; Buydens-Branchy, Nourmair, & Branchy, 1990; Pitman, Altman & Macklin, 1989). For example, using the percentage of burned area and presence of facial disfigurement as a measure of objective injury severity, Perry, Difede, Musngi, Frances and Jacobsberg (1992) demonstrated that burn victims with less severe burns were more likely to develop PTSD 2 months after their injury than participants with more severe burns. In contrast, a study by Patterson et al. (1990) using the total body surface burn area as a measure of objective injury severity, indicated a positive correlation between the extent of burn and PTSD. Additionally, Curran et al., (1990) showed that bomb victims with significantly less severe injuries were more likely to develop PTSD than those who had a higher severity of injury; whereas other studies have demonstrated a positive correlation between more severe injuries and higher PTSD symptomatology in rail accident victims (Selley et al., 1997) and moderately injured terrorist attack victims (Abenhaim, Dab & Salmi 1992). This disparity in results may potentially be reflective of methodological and sampling differences, or alternatively the heterogeneous manifestation of PTSD. Nonetheless, the mixed results raise some uncertainty about the reliability of objective injury severity as a consistent predictor of mental health disorder (in this case, PTSD).

When injury is measured using subjective self-report tools (that is, the severity of injury as perceived and subsequently reported by the individual), there appears to be a more consistent relationship with mental health outcomes. Namely, Bryant and Harvey (1995) demonstrated that subjective accounts of injury severity were more accurate predictors of PTSD than the ISS - a finding which has been replicated in later studies by Harvey and Bryant (2000) and Haden, Jones and Ollendick (2007). This

finding was extended in a study by Jeavons (2000), who demonstrated that subjective injury severity was more predictive of chronic PTSD symptomatology (operationalised as 12 months after injury) than acute symptoms which occurred within a few months after the injury. This association between subjective severity and outcome may be linked with the role of appraisal of threat and subsequent perceived ability to cope with that threat in the development of PTSD (Ehlers & Clark, 2000). However, caution must be taken in interpreting these results given that subjective, retrospective reports of injury severity have also been found to be influenced by posttraumatic symptomatology (Delahanty, Raimonde, Spoonster, & Cullado, 2003).

Complicating this domain further are the findings derived from studies that have concurrently measured both objective and subjective levels of injury severity. In this body of research, results have consistently demonstrated no relationship between the objective and subjective levels of severity (e.g., Gabert-Quillen, Fallon, & Delahanty, 2011; Schnyder et al., 2001a; Schnyder et al., 2001b). This reduces confidence in the use of any objective measures of severity as a predictor of mental health outcome, as it reduces clarity of the relationship between mental health symptomatology and injury severity.

Methodological variability between research designs is likely to have contributed to the difference in results and findings. Again, studies measuring injury severity have frequently included a restricted sample using either a homogeneous population (such as MVA survivors or soldiers), or using a restricted range of injury severity (for example, including only ‘very severely injured’ or ‘moderately injured patients; Schnyder et al., 2001). Ultimately, this limits the generalisability to a broader range of traumatically injured individuals. This suggests that conducting a study

incorporating a breadth of injury severities experienced by a comparatively more heterogeneous group of individuals, and measuring a number of mental health outcomes, would extend our understanding of the role and impact of severity of injury further and allow a comprehensive comparison of injury severities and their specific outcomes.

Additional Considerations in Evaluating Traumatic Injury

1.8.1 The Nature of Traumatic Injury

The nature of traumatic injury itself causes challenges in its examination. That is, the heterogeneity of events precipitating the injury, such as civil conflicts, MVAs, suicide attempts and falls, may all contribute to the development of PTSD, anxiety, and/or depression to varying degrees (Ozer et al., 2003). The extent and manner in which these precipitating events contribute to the development of specific mental health outcomes has yet to be determined, and although beyond the scope of the current project, would benefit from being directly evaluated to identify the similarities and differences in their impact on injury (Steel et al., 2011). Notwithstanding this unknown impact, it is likely that any mental health outcomes could be additionally impacted by other well-established predictors of poor mental health outcome (such as psychiatric history and gender; Ozer et al., 2003). The potential level of interaction between known and unknown predictors, inclusive of event, injury, and personality characteristics, serves to complicate the study of traumatic injury further.

Symptomatology reported by many patients with physical injury has been found to be associated with organic or functional pathology, rendering the differentiation between physical and psychological causes of specific symptoms

difficult (O'Donnell et al., 2003). Symptom overlap is common between psychological conditions. For example, hyper-arousal can be a symptom of anxiety as well as PTSD; and sleep disturbances, disrupted concentration and lowered frustration tolerance can be features of both depression and PTSD. All of these symptoms, may also be secondary to pain (Raymond et al., 2001), discomfort and noise in the hospital environment or the injury itself (Haboubi et al., 2001). Further, the effect of analgesic medication (including side effects such as sweating, confusion, disorientation and mood changes), overlaps with a range of dissociative and anxiety reactions; and may serve to mask a number of symptoms in the acute hospitalisation phase (O'Donnell et al., 2003). For this reason, psychological assessments should be conducted at least 24 hours after cessation of narcotic analgesic medication to minimise the potential confound of medication. Future studies should also clearly define and report upon the parameters for distinguishing between functional and organic bases of a reported symptom; and where possible, standardise these parameters within the study (O'Donnell et al., 2003). In this way, confidence in the traumatic injury research results can be increased.

1.8.2 Traumatic Brain Injury

The presence of Traumatic Brain Injury (TBI) is a further confounding factor when assessing the impact of physical injury. There is considerable overlap between the dissociative, hyperarousal and intrusive imagery symptoms of PTSD that also occur in TBI patients. Further, TBI may mask some psychiatric symptoms (O'Donnell et al., 2003). Van Reekum, Cohen and Wong (2000), ascertained that damage to the frontal lobe may yield expressive aphrodosy that can subsequently reduce the expression of dysphoria. Similarly, McMillan (2001) established that cognitive impairment may

contribute to inaccurate completion of self-report scales of psychological functioning. This may, in turn, impact the accuracy of traumatic injury prevalence studies if TBI is not adequately acknowledged within the study design. In order to mitigate these impacts throughout the research on traumatic injury and specific mental health outcomes, it is recommended that inclusion criteria emphasise only mild TBI as a maximum; and either exclude, or control for, participants with moderate or severe TBI.

1.8.3 Comorbidity

Finally, comorbidity is a significant factor that complicates the study of injury, particularly given the overlap of symptomatology between anxiety, depression and PTSD (O'Donnell et al., 2003). Comorbidity after traumatic injury has been found to be almost more commonplace than the development of a single psychiatric outcome (Blanchard et al., 1994; O'Donnell et al., 2004). Breslau, Davis, Peterson, and Schultz (2000) established that 84% of their sample met criteria for PTSD and at least one other psychiatric disorder, most commonly major depression. An Australian study conducted by Creamer, Burgess and McFarlane (2001) examined PTSD in a national survey and, similarly to Kessler et al.'s (1995) National Comorbidity Study, found that 85% of participants with PTSD had experienced an additional DSM-IV Axis I disorder in the previous 12 months. However, despite the established frequency of comorbidity following injury, many of the reviewed studies neither report nor measure comorbidity (Steel et al., 2011), which is likely to have affected the accuracy of prevalence studies and maintained the lack of clarity of the overall impact of traumatic injury on mental health. It is evident that the traumatic injury literature would benefit from inclusion of comorbidity measures in future studies, in order to distinguish the impact of individual and overlapping mental health outcomes.

Clinical Implications of Traumatic Injury and Mental Health Outcome

1.9.1 Screening, Early Intervention and Economic Implications

Screening is an essential component in the identification of individuals who require psychological intervention. Screening for vulnerability to a particular disorder will facilitate the development and subsequent implementation of appropriately targeted early intervention (models); and has been shown to successfully reduce the likelihood of developing disorders such as PTSD and depression (Bryant et al., 2003; Ehlers et al., 2003). Economically, early intervention strategies have been demonstrated to be a cost effective way of addressing trauma-related psychopathology (National Collaborating Centre for Mental Health, 2005). Indeed Kessler et al. (2000) reported that the cost of implementing early intervention programs is likely to be significantly less than the economic and indirect burden (inclusive of work absenteeism, stress of social relationships and service usage) of psychiatric disorders after injury. Therefore, understanding the role, impact and predictive power of specific injury characteristics such as the site and severity of injury, will be beneficial in the development of stronger and more accurate screening tools (O'Donnell et al., 2008; Richmond et al., 2011) and contribute to reducing the economic burden of injury. Furthermore, O'Donnell et al., (2009) have demonstrated that PTSD (including sub-syndromal PTSD) and depression in the first three months after injury significantly increases the risk of disability at 12 months after injury. By using accurate screening tools (which take into account any physical injury vulnerability inclusive of injury characteristics) to guide early intervention, the likelihood of disability and the longer-term social and psychological effects may be mitigated.

1.10 Summary and Rationale of Research Project

Traumatic injury is significantly associated with mental health sequelae and has demonstrated a subsequent economic, psychosocial and service usage burden. Whilst the nature of injury itself has presented challenges in conducting methodologically rigorous studies that accurately ascertain the relationship between injury and discrete mental health outcomes, the (limited) literature to date has documented some preliminary trends. These include depression, anxiety and PTSD as commonly exhibited outcomes following injury; with prevalence ranging between 8 and 60% for depression; 16 and 40% for anxiety; and 2 and 35% for PTSD (Davydow et al., 2009; Horner et al., 2008; Steel et al., 2011). Furthermore, psychological predictors for each outcome have been established to include female gender, younger age, limited social support, and psychiatric history (Ouellet et al., 2009; Steel et al., 2011).

However, whilst these psychological and demographic predictors have been relatively well documented, the impact of injury-specific characteristics (in particular site and severity) as predictors, and comparisons between mental health outcomes, is largely untested. This may be partially due to the studies to date focusing on a restricted sample or population group, and/or measuring singular outcomes; which in turn has not enabled a comparison to occur. The consequences of the methodological issues on the understanding of traumatic injury and mental health outcomes, are simple but important: the variability in timing of assessments, use and operationalisation of outcome measures, sample selection and overall design reduce the representativeness of results to wider injury populations.

Informed by the strengths and weaknesses of the existing body of traumatic injury research and in particular the methodological limitations that have been outlined in this chapter, the program of research presented in the next two empirical chapters

will extend the current literature by using a large-scale prospective, longitudinal design with a heterogeneous population of adult participants who have experienced a wide range of injury severities across different sites of injury, measuring three different mental health outcomes, notably anxiety, PTSD and depression. This will enable an evaluation of the overall patterns of mental health outcome across the 12 months following traumatic injury and an investigation of the impact of site and severity of injury as predictors of depression, anxiety and PTSD. This program of research will also provide a comparative evaluation of the impact and role of injury characteristics as predictors of a depression, anxiety and PTSD symptom severity following traumatic injury. The findings from this research has the potential scope to further inform the development of screening tools and recommendations for appropriate early intervention where required, in the hope of ultimately contributing to a reduction of the psychological and financial burden of traumatic injury.

1.11 Objectives and Structure of Project

The aim of this research project is to identify the impact of traumatic injury on depression, anxiety and PTSD. In order to so, the objective of the program of research was to evaluate three key research questions across two studies. Chapter One has provided a summary and examination of the relevant current literature in the traumatic injury and mental health domains; and identified a number of methodological and empirical gaps within the field. Chapter Two will examine the first research question investigated in this program of study; specifically, the trajectory patterns of anxiety, depression and PTSD over the 12 months following traumatic injury. Chapter Three will then directly examine the influence of both site of injury and severity of injury respectively on PTSD, depression and anxiety. Finally, Chapter Four will provide an

overall discussion and synthesis of the combined findings from this program of research, and conclude with clinical implications and areas for further study.

1.12 References

Abenhaim, L., Dab, W., & Salmi, L.R. (1992). Study of civilian victims of terrorist attacks (France 1982-1987). *Journal of Clinical Epidemiology, 45*, 103-109.

Amstadter, A., & Vernon, L. (2008). Emotional reactions during and after trauma: A comparison of trauma types. *Journal of Aggression, Maltreatment & Trauma, 16*(4), 391-408.

Baker, S.P., & O'Neill, B. (1976). The Injury Severity Score: An update. *The Journal of Trauma, 16*(11), 885-885.

Baker, S.P., O'Neill, B., Haddon, W., & Long, W.B. (1974). The Injury Severity Score: A Method for describing patients with multiple injuries and evaluating emergency care. *The Journal of Trauma, 14*(3), 187-196.

Bergner, M., Bobbitt, R.A., Carte, W.B., & Gilson, B.S. (1981). The Sickness Impact Profile: development and final revision of a health status measure. *Medical Care, 19*, 787-805.

Bernat, J.A., Ronfeldt, H.M., Calhoun, K.S., & Arias, I. (1998). Prevalence of traumatic events and peritraumatic predictors of posttraumatic stress symptoms in a nonclinical sample of college students. *Journal of Traumatic Stress, 11*(4), 645-664.

Blanchard, E.B., Hickling, E.J., Freidenberg, B.M., Malt, L.S., Kuhn, E., & Sykes, M.A. (2004). Two studies of psychiatric morbidity after motor vehicle accident survivors 1 year after the crash. *Behaviour Research and Therapy, 42*, 569-583.

Blanchard, E.B., Hickling, E.J., Taylor, A.E., Loos, W.R., Forneris, C.A., & Jaccard, J. (1996). Who develops PTSD from motor vehicle accidents? *Behaviour Research Therapy, 34*(1), 1-10.

Blaszczynski, A., Gordon, K., Silove, D., Sloane, D., Hillman, K., & Panasetis, P. (1998). Psychiatric morbidity following motor vehicle accidents: A review of methodological issues. *Comprehensive Psychiatry, 39*(3), 111-121.

Bonanno, G.A., Kennedy, P., Galatzer-Levy, I.R., Lude, P., & Elfstrom, M.L. (2012). Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabilitation Psychology, 57*(93), 236-247.

Breslau, N., Davis, G.C., Peterson, E.L., & Schultz, L.R. (2000). A second look at comorbidity in victims of trauma: The posttraumatic stress disorder – major depression connection. *Biological Psychiatry, 48,* 902-909.

Brewin, C.R. (2005). Systematic review of screening instruments for adults at risk of PTSD. *Journal of Traumatic Stress, 18*(1), 53-62.

Brewin, C.R., Andrews, B., & Valentine, J.D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology, 68*(5), 748-766.

Bryant, R.A. (2011). Mental disorders and traumatic injury. *Depression and Anxiety, 28,* 99-102.

Bryant, R.A., & Harvey, A.G. (1995). Psychological impairment following motor vehicle accidents. *Australian Journal of Public Health, 19,* 185-190.

Bryant, R.A., O'Donnell, M.L., Creamer, M.C., McFarlane, A.C., Clark, C.R., & Silove, D. (2010). The psychiatric sequelae of traumatic injury. *American Journal of Psychiatry, 167*, 312-320.

Bull, J.P. (1975). The Injury Severity Score of road traffic casualties in relation to mortality, time of death, hospital treatment time and disability. *Accident Analysis and Prevention,7,* 249-255.

Buydens-Branchy, L., Noumair, D., & Branchy, M. (1990). Duration and intensity of combat exposure and posttraumatic stress disorder among Vietnam veterans. *Journal of Nervous and Mental Disease, 178,* 582-582.

Cameron, C., Purdie, D.M., Kliewer, E.V., & McClure, R.J. (2006). Mental health: A cause or consequence of injury? A population-based matched cohort study. *BioMed Central Public Health, 6,* 114-123.

Creamer, M., Burgess, P., & McFarlane, A.C. (2001). Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychological Medicine, 31*, 1237-1247.

Curran, P.S., Bell, P., Murray, A., Loughrey, B., Roddy, R., & Rocke, L.G. (1990). Psychological consequences of the Enniskillen bombing. *British Journal of Psychiatry, 156*, 479-482.

Darnall, B.D., Ephraim, P., & Wegener, S.T. (2005). Depressive symptoms and mental health service utilization among persons with limb loss: results of a national survey. *Archives of Physical Medicine and Rehabilitation, 86*, 650-658.

Davydow, D.S., Zatzick, D.F., Ruvara, F.P., Jurkovich, G.J., Wang, J., Roy-Byrne, P.P.,… Mackenzie, E.J. (2009). Predictors of posttraumatic stress disorder and return to usual major activity in traumatically injured intensive care unit survivors. *General Hospital Psychiatry, 31*, 428-435.

Delahanty, D.L., Raimonde, A.J., Spoonster, E., & Cullado, M. (2003). Injury severity, prior trauma history, urinary cortisol levels, and acute PTSD in motor vehicle accident victims. *Journal of Anxiety Disorders, 17*(2), 149-164.

deRoon-Cassini, T.A., Mancini, A.D., Rusch, M.D., & Bonanno, G.A. (2010). Psychopathology and resilience following traumatic injury: A latent growth mixture model analysis. *Rehabilitation Psychology, 55*(1), 1-11.

Edwards, E.R., Smith, M.T., Klick, B., Magyar-Russell, G., Haythornewaite, J.A., & Holavanahalli, R. (2007). Symptoms of depression and anxiety as unique predictors of pain-related outcomes following burn injury. *Annals of Behavioural Medicine, 34*(3), 313-322.

Ehlers, A., & Clark, D.M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy*, 38, 319-345.

Ehlers, A., Mayou, R.A., & Bryant, B. (1998). Psychological predictors of chronic posttraumatic stress disorder after motor vehicle accidents. *Journal of Abnormal Psychology, 107*, 508-519.

Frueh, B.C., Hammer, M.B., Cahill, S.P., Gold, P.B., & Hamlin, K.L. (2000). Apparent symptom overreporting in combat veterans evaluated for PTSD. *Clinical Psychology Review, 20*(7), 853-885.

Fukunishi, I. (1999). Relationship of cosmetic disfigurement to the severity of posttraumatic stress disorder in burn injury or digital amputation. *Psychotherapy and Psychosomatics, 68*, 82-86.

Gabert-Quillen, C.A., Fallon, W., & Delahanty, D.L. (2011). PTSD after traumatic injury: An investigation of the impact of injury severity and peritraumatic moderators. *Journal of Health Psychology, 16*(4), 678-687.

Glynn, S. M., Shetty, V., & Dent, M. (2010). The long-term psychological sequelae of orofacial injury. *Oral Maxillofacial Surgery Clinical North America, 22*(2), 217-224.

Goldberg, D. (1978). Manuel of the General Health Questionnaire. Windsor: NFER-Nelson.

Grieger, T.A., Cozza, S.J., Ursano, R.J., Hoge, C., Martinez, P.E., Engel, C.C., & Wain, H.J. (2006). Posttraumatic stress disorder and depression in battle-injured soldiers. *American Journal of Psychiatry, 163,* 1777-1783.

Haagsma, J.A., Ringburg, A.N., van Lieshout, E.M., van Beeck, E.F., Patka, I.B., & Polinder, S. (2012). Prevalence rate, predictors and long-term course of probably posttraumatic disorder after major trauma: a prospective cohort study. *BioMed Central Psychiatry, 12,* 236-245.

Haboubi, N.H., Long, J., Koshy, M., & Ward, A.B. (2001). Short-term sequelae of minor head injury (6 years' experience of minor head injury clinic). *Disability Rehabilitation, 23*(14), 635-638.

Haden, S.C., Scarpa, A., Jones, R.T., & Ollendick, T.H., (2007). Posttraumatic stress disorder symptoms and injury: The moderating role of perceived social support and coping for young adults. *Personality and Individual Differences, 42*(7), 1187-1198.

Harris, I.A., Young, J.M., Rae, H., Jalaludin, B.B., & Solomon, M.J. (2008). Predictors of posttraumatic stress disorder following major trauma. *ANZ Journal of Surgery, 78,* 583-587.

Harvey, A.G., & Bryant, R.A. (2000). A two year prospective evaluation of the relationship between acute stress disorder and posttraumatic stress disorder following mild traumatic brain injury. *Journal of Abnormal Psychology, 109,* 341-344.

Holbrook, T., Anderson, J., Sieber, W.J., Browner, D., & Hoyt, D.B. (1998). Outcome after major trauma: discharge and 6-month follow-up results from the Trauma Recovery Project. *The Journal of Trauma: Injury, Injection, and Critical Care, 45,* 315-324.

Holbrook, T., Anderson, J., Sieber, W.J., Browner, D., & Hoyt, D.B. (1999). Outcome after major trauma: 12-month and 18-month follow-up results from the Trauma Recovery Project. *The Journal of Trauma: Injury, Injection, and Critical Care, 46*(5), 765-773.

Holbrook, T.L., Hoyt, D.B., & Anderson, J.P. (2001). The impact of major in-hospital complications on functional outcome and quality of life after trauma. *Journal of Trauma, 50*(1), 91-95.

Holbrook, T.L., Hoyt, D.B., Stein, M.B., & Sieber, W.J. (2001). Perceived threat to life predicts posttraumatic stress disorder after major trauma: Risk factors and functional outcome. *The Journal of Trauma: Injury, Infection, and Critical Care, 51*, 287-293.

Holtslag, H.R., Post, M.W., Lindeman, E., & van der Werken, C. (2007a). Long-term functional health status of severely injured patients. *Injury, 38,* 280-289.

Holtslag, H.R van Beeck, E.F., Lindeman, E., & Leenan, L.P.H. (2007b). Determinants of long-term functional consequences after major trauma. *The Journal of Trauma: Injury, Infection and Critical Care, 62*(4), 919-927.

Horner, M.D., Selassie, A.W., Lineberry, L., Ferguson, P.L., & Labbate, L.A. (2008). Predictors of psychological symptoms 1 year after traumatic brain injury: a population-

based, epidemiological study. *Journal of Head Trauma and Rehabilitation, 23*(2), 74-83.

Horowitz, M., Wilmner, N., & Alvarez, W. (1979). Impact of Events Scale: a measure of subjective stress. *Psychomotor Medicine, 41*(3), 209-218.

Islam, S., Ahmed, M., Walton, G.M., Dinan, T.G., & Hoffman, G.R. (2010). The association between depression and anxiety disorders following facial trauma – A comparative study. *Injury, 41,* 92-96.

Islam, S., Ahmed, M., Walton, G.M., Dinan, T.G., & Hoffman, G.R. (2012). The prevalence of psychological distress in a sample of facial trauma victims. A comparative cross-sectional study between UK and Australia. *Journal of Cranio-Maxillo-Facial Surgery, 40,* 82-85.

Jeavons, S. (2000). Predicting who suffers from psychological trauma in the first year after a road accident. *Behaviour Research and Therapy, 38*(5), 499-508.

Joy, D., Probert, R., Bisson, & Shepherd, J.P. (2000). Posttraumatic stress reactions after injury. *The Journal of Trauma: Injection, Infection and Critical Care, 48*(3), 490-494.

Kessler, R.C., Sonnega, A., Hughes, M., & Nelson, C.B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry, 52,* 1048-1060.

King, D.W., King, L.A. McArdle, J.J., Grimm, K., Jones, R.T., & Ollendick, T.H. (2006). Characterizing time in longitudinal trauma research. *Journal of Traumatic Stress, 19,* 205-215.

Koren, D., Arnon, I., & Klein, E. (1999). Acute stress response and posttraumatic stress disorder in traffic accident victims: A one year prospective, follow-up study. *American Journal of Psychiatry, 156*(3), 367-373.

Koren, D., Norman, D., Cohen, A., Berman, J. & Klein, E.M. (2005). Increased PTSD risk with combat-related injury: A matched comparison study of injured and uninjured soldiers experiencing the same combat events. *American Journal of Psychiatry, 162*(2), 276-282.

Kreis, B.E., Castano, N.J.Y., Tuinebreijer, W.E., Hoogenboom, L.C.A., Meylaerts, S.A.G., & Rhemrev, S.J. (2011). Characteristics of polytrauma patients with posttraumatic stress disorder in a level 1 trauma center. *European Journal of Trauma and Emergency Surgery, 37,* 269-275.

Krug, E., Sharma, G., & Lozano, R. (2000). The global burden of injuries. *American Journal of Public Health, 90,* 523-526.

Lavoie, A., Moore, L., LeSage, N., Liberman, M., & Sampalis, J.S. (2004). The New Injury Severity Score: A more accurate predictor of in-hospital mortality than the Injury Severity Score. *The Journal of Trauma: Injury, Infection, and Critical Care, 56,* 1312-1320.

Madianos, M.G., Papaghelis, M., Ioannovich, J., & Dafni, R. (2001). Psychiatric disorders in burn patients: A follow-up study. *Psychotherapy and Psychosomatics, 70,* 30-37.

Mason, S., Turpin, G., Woods, D., Wardrope, J., & Rowlands, A. (2006). Risk factors for psychological distress following injury. *British Journal of Clinical Psychology, 45,* 217-230.

Mason, S., Wardrope, J., Turpin, G., & Rowlands, A. (2002). The psychological burden of injury: an 18 month prospective cohort study. *Emergency Medicine, 19,* 400-404.

Mayou, R., & Bryant, B. (2002). Outcome 3 years after a road traffic accident. *Psychological Medicine, 32,* 671-675.

Mayou, R., & Bryant, B. (2003). Consequences of road traffic accidents for different types of road user. *Injury, 34,* 197-202.

Mayou, R., Bryant, B., & Ehlers, A. (2001). Prediction of psychological outcomes one year after a motor vehicle accident. *American Journal of Psychiatry, 158,* 1231-1238.

Mayou, R., Tyndel, S., & Bryant, B. (1997). Long-term outcome of motor vehicle accident injury. *Psychosomatic Medicine, 59*(6), 578-584.

McMillan, T.M. (2001). Errors in diagnosing post-traumatic stress disorder after traumatic brain injury. *Brain Injury, 15,* 39-46.

Mellman, T.A, David, D., & Bustamante, V. (2001). Predictors of posttraumatic stress disorder following severe injury. *Depression and Anxiety, 14,* 226-231.

Michaels, A.J., Michaels, C.E., Moon, C.H., Smith, J.S., Zimmerman, M.A., Taheri, P.A., & Peterson, C. (1999). Posttraumatic stress disorder after injury: Impact on general health outcome and early risk assessment. *The Journal of Trauma: Injury, Infection, and Critical Care, 47*(3), 460-467.

Michaels, A.J., Michaels, C.E., Zimmerman, M.A., Smith, J.S., Moon, C.H., & Peterson, C. (1999). Posttraumatic stress disorder in injured adults: Etiology by path analysis. *The Journal of Trauma: Injury, Infection, and Critical Care, 47*(5), 867-877.

Mohta, M., Sethi, A.K., Tyagi, A., & Mohta, A. (2003). Psychological care in trauma patients. *Injury, 34,* 17-25.

National Collaborating Centre for Mental Health. (2005). Posttraumatic stress disorder: The management of PTSD in adults and children in primary and secondary care. Clinical Guideline 26, National Centre for Clinical Excellence, London.

O'Donnell, M.L., Bryant, R.A., Creamer, M., & Carty, J. (2008). Mental Health following traumatic injury: Toward a health system model of early psychological intervention. *Clinical Psychology Review, 28*(3), 387-406.

O'Donnell, M.L., Creamer, M., Bryant, R.A., Schnyder, U., & Shalev, A. (2003). Posttraumatic disorders following injury: an empirical and methodological review. *Clinical Psychology Review, 23,* 587-603.

O'Donnell, M.L., Creamer, M., Elliot, P., Bryant, R., McFarlane, A., & Silove, D. (2009). Prior trauma and psychiatric history as risk factors for intentional and unintentional injury in Australia. *The Journal of Trauma: Injury, Infection, and Critical Care, 66,* 470-476.

O'Donnell, M.L., Creamer, M., Parslow, R., Elliot, P., Holmes, A.C.N., Ellen, S.,… Bryant, R.A. (2008). A predictive screening index for posttraumatic stress disorder and depression following traumatic injury. *Journal of Consulting and Clinical Psychology, 76*(6), 923-932.

O'Donnell, M.L., Creamer, M., & Pattison, P. (2004). Posttraumatic stress disorder and depression following trauma: Understanding comorbidity. *American Journal of Psychiatry, 161,* 1390-1396.

O'Donnell, M.L., Creamer, M., Pattison, P., & Atkin, C. (2004). Psychiatric morbidity following injury. *American Journal of Psychiatry, 161*(3), 1-9.

Osler T., Baker, S., & Long, W. (1997). A modification of the Injury Severity Score that both improves accuracy and simplifies screening. *The Journal of Trauma: Injury, Infection and Critical Care, 43*(6), 922-926.

Ouellet, M.C., Sirois, M.J., & Lavoie, A. (2009). Perceived mental health and needs for mental health services following trauma with and without brain injury. *Journal of Rehabilitation Medicine, 41,* 179-186.

Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). Predictors of post-traumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129,* 52-73.

Patterson, D.R., Carrigan, L., Questad, K.A., & Robinson, R. (1990). Post-traumatic stress disorder in hospitalised patients with burn injuries. *Journal of Burn Care Rehabilitation, 11*(3), 181-184.

Perrin, S., Van Hasselt, V.B., Basilio, I., & Hersen, M. (1996). Assessing the effects of violence on women in battering relationships with the Keanne MMPI-PTSD Scale. *Journal of Traumatic Stress, 9*(4), 805-816.

Perry, S., Difede, J., Musngi, G., Frances, A.J., & Jacobsberg, L. (1992). Predictors of posttraumatic stress disorder after burn injury. *American Journal of Psychiatry, 149,* 931-935.

Pitman, R.K., Altman, B., & Macklin, M.L. (1989). Prevalence of posttraumatic stress disorder in wounded Vietnam veterans. *American Journal of Psychiatry, 146*, 667-669.

Quale, A.J., Schanke, A., Froslie, A.F., & Roise, O. (2009). Severity of injury does not have any impact on posttraumatic stress symptoms in severely injured patients. *Injury,* 40, 498-505.

Quale, A.J., & Schanke, A. (2010). Resilience in the face of coping with a severe physical injury: A study of trajectories of adjustment in a rehabilitation setting. Rehabilitation Psychology, 55(1), 12-22.

Raymond, I., Nielsen, T.A., Lavigne, G., Manzini, C., & Choiniere, M. (2001). Quality of sleep and its daily relationship to pain intensity in hospitalised adult burn patients. *Pain, 92*(3), 381-388.

Read, K.M., Kufera, J.A., Dischinger, P.C., Kerns, T.J., Ho, S.M., Burgess, A.R., & Burch, C.A. (2004). Life-altering outcomes after lower extremity injury sustained in motor vehicle crashes. *The Journal of Trauma: Injury, Infection and Critical Care, 57*(4), 815-823.

Richmond, T.S., & Kauder, D. (2000). Predictors of psychological distress following serious injury. *Journal of Traumatic Stress, 13*(4), 681-691.

Richmond, T.S., Ruzek, J., Ackerson, T., Wiebe, D.J., Winston, F., & Kassam-Adams, N. (2011). Predicting the future development of depression or PTSD after injury. *General Hospital Psychiatry, 33*, 327-335.

Schnyder, U., Moergeli H., Klaghofer, R., & Buddeberg, C. (2001a). Incidence and prediction of posttraumatic stress disorder symptoms in severely injured accident victims. *American Journal of Psychiatry, 158,* 594-599.

Schnyder, U., Moergeli H., Trentz, O., Klaghofer, R., & Buddeberg, C. (2001b). Prediction of psychiatric morbidity in severely injured accident victims at one-year follow-up. *American Journal of Respiratory and Critical Care, 164,* 653-656.

Selley, C., King, E., Peveler, R., Osola, K., Martin, N., & Thompson, C. (1997). Posttraumatic stress disorder symptoms and the Clapham rail accident. *British Journal of Psychiatry, 171*, 478-482.

Semmlow, J.L., & Core, R. (1976). Applications of the Injury Severity Score: An independent confirmation. *Health Services Research,* 11, 45-52.

Shalev, A.Y., Freedman, S., Peri, T., Brandes, D., Sahar, T., Orr, S.P., & Pitman, K. (1998). Prospective study of posttraumatic stress disorder and depression following trauma. *American Journal of Psychiatry, 155*(5), 630-637.

Sluys, K., Haggmark, T., & Iselius, L. (2005). Outcome and quality of life 5 years after major trauma. *The Journal of Trauma: Injury, Infection and Critical Care, 59*(1), 223-232.

Sorberg, H.L., Bautz-Holter, E., Roise, O., & Finset, A. (2010). Mental health and posttraumatic stress symptoms 2 years after severe multiple trauma: self-reported disability and psychosocial functioning. *Archives of Physical and Medical Rehabilitation, 91,* 481-488.

Starr, A.J., Smith, W.R., Borer, D.S., Morgan, S.J., Reinert, C.M., & Mendoza-Welch, M. (2004). Symptoms of posttraumatic stress disorder after orthopaedic trauma. *The Journal of Bone and Joint Surgery, 86*(6), 1115-1121.

Steel, J.L., Dunlavy, A.C., Stillman, J., & Paper, H.C. (2011). Measuring depression and PTSD after trauma: common scales and checklists. *Injury, 42*(3), 288-300.

Van Horn, E.R. (2009). Loss and depression after traumatic injury: the importance of case management in the recovery process. *Professional Case Management, 14*(2), 66-73.

Van Reekum, R., Cohen, T., & Wong, J. (2000). Can traumatic brain injury cause psychiatric disorders? *Journal of Neuropsychiatry and Clinical Neuroscience, 12*(3), 316-327.

Varney, N.R., Martzke, J.S., & Roberts, R.J. (1987). Major depression in patients with closed head injury. *Neuropsychology, 1*(1), 7-9.

Vles, W.J., Steyerberg, E.W., Essink-Bot, M-L., van Beeck, E.F., Meeuwis, J.D., & Leenen, L.P.H. (2005). Prevalence and determinants of disabilities and return to work after major trauma. *The Journal of Trauma, 58*(1), 126-135.

Wang, C-H., Tsay, S-L., & Bond, A.E. (2005). Posttraumatic stress disorder, depression, anxiety and quality of life in patients with traffic-related injuries. *Journal of Advanced Nursing, 52*(1), 22-30.

Wiseman, T., Foster, K., & Curtis, K. (2013). Mental health following traumatic physical injury: An integrative literature review. *Injury, 44,* 1393-1390.

Whittemore, R., & Knafl, K. (2005). The integrative review: updated methodology. *Journal of Advanced Nursing, 52*(5), 546-553.

Woolrich, R.A., Kennedy, P., & Tasiemski, T. (2006). A preliminary psychometric evaluation of the Hospital Anxiety and Depression Scale (HADS) in 963 people living with a spinal cord injury. *Psychology, Health & Medicine, 11*(1), 80-90.

Zatzick, D., Jurkovich, G., Rivara, F., Wang, J., Fany, M., Joesch, J., & Mackenzie, E. (20084). A national US study of posttraumatic stress disorders, depression, and work

and functional outcomes after hospitalisation for traumatic injury. *Annals of Surgery, 248* (3), 429-437.

Zatzick, D., Jurkovich, G., Russo, J., Roy-Byrne, P., Katon, W., Wagner, A.,… Rivara, F. (2004). Posttraumatic distress, alcohol disorders, and recurrent trauma across Level 1 Trauma Centers. *The Journal of Trauma, injury, infection and critical care, 57*(2), 360-366.

Zatzick, D.F., Jurkovich, G.J., Gentilello, L., Wisner, D., & Rivara, F.P. (2002). Posttraumatic stress, problem drinking and functional outcomes after injury. *Archives of Surgery, 137*, 200-205.

Zatzick, D.F., Kang, S-M., Hinton, W.L., Kelly, R.H., Hilty, D.M., Franz, C.E.,… Kravitz, R.L. (2001). Posttraumatic concerns: A patient-centre approach to outcome assessment after traumatic physical injury. *Medical Care, 39*(4), 327-339.

Zatzick, D.F., Kang, S., Muller, H., Russo, J.E., Rivara, F.P., Katon, W.,… Roy-Burne, P. (2002). Predicting posttraumatic distress in hospitalised trauma survivors with acute injuries. *American Journal of Psychiatry, 159*, 941-946.

Zatzick, P., Roy-Burne, P., Russo, J., Rivara, F., Droesch, R., & Wagner, A. (2004). A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Archives of General Psychiatry, 61*(5), 498-506.

Zigmund, A.S., & Snaith, R.P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica, 67*(6), 361-370.

Chapter Two. A Comparison of the Longitudinal Trajectories of Depression, Anxiety and PTSD Symptoms following Traumatic Injury

2.1 Abstract

***Objective*:** Four trajectories of mental health outcomes have been consistently identified following exposure to a traumatic event. However, these have been sparsely examined in a traumatically (physically) injured population, particularly in a comparative evaluation between different mental health outcomes. The aim of this study was to identify and compare the trajectories of anxiety, depression, and posttraumatic stress disorder (PTSD) symptom severity following traumatic injury. To further understand the mechanisms that might influence the development of these trajectories, a second aim was to explore whether specific socio-demographic variables influenced these trajectories.

***Method*:** Utilizing a multi-site prospective longitudinal study, participants with a traumatic physical injury (N=1098) were assessed during hospital admission, and followed up at 3 months (N=932, 86%) and at 12 months (N=715, 71%). Participants completed the Hospital Anxiety and Depression Scale (HADS), Clinician Administered PTSD Scale (CAPS) and the Mini International Neuropsychiatric Interview (MINI version 5.5). A random intercept mixed modelling analysis was conducted to evaluate the longitudinal trajectory patterns of anxiety, depression and PTSD symptomatology.

***Results*:** Levels of anxiety changed significantly between each time point, increasing at a non-linear rate over 12 months, and reflected a delayed-onset trajectory. Levels of depression changed significantly over time, decreasing at a nonlinear rate over 12 months, which aligned with a recovery trajectory. Levels of PTSD symptoms changed significantly between time points, also aligning with a recovery trajectory. However, simple effect analyses indicated a significant difference in the rates of change for PTSD symptoms relative to depressive symptoms over the 12-month

period. The inclusion of age, gender and psychiatric history in the model did not alter these trajectory patterns.

***Conclusions*:** These results indicate that traumatic injury has a long-term negative impact on mental health, which manifests in different trajectory patterns for depression, anxiety and PTSD symptomatology. These findings support the implementation of screening for mental health problems during the hospitalisation period following injury; and the subsequent provision of targeted treatment to address the identified anxiety, depressive and PTSD symptom profiles.

2.2 A Comparison of the Longitudinal Trajectories of Depression, Anxiety and PTSD symptoms following Traumatic Injury

Australian epidemiological studies have demonstrated a lifetime prevalence of 64.6% of men and 49.5% of women reporting at least one traumatic event in their lives (Creamer, Burgess, & McFarlane, 2001). Indeed, Creamer et al.'s (2001) study found that being in an accident leading to physical injury was the second most common type of traumatic event experienced by the Australian population, a statistic which serves to highlight the high incidence experienced within the general public. Traumatic injury (operationalised within the relevant literature as physical injury severe enough to require hospitalisation; O'Donnell, Bryant, Creamer, & Carty, 2008; Quale & Schanke, 2010) has been found to be a leading contributing factor to trauma-related psychiatric disorders (O'Donnell et al., 2008). O'Donnell, Creamer and Pattison (2004) established that over 20% of injury survivors met diagnostic criteria for at least one psychiatric diagnosis 12 months after their injury, with posttraumatic stress disorder (PTSD) and depression as the most frequent diagnoses; a finding which is commensurate with other studies (Davydow et al., 2009; deRoon-Cassini, Mancini, Rusch, & Bonanno, 2010; O'Donnell, Creamer, Bryant, Schnyder, & Shalev, 2003; Starr et al., 2004; Wiseman, Foster, & Curtis, 2013). As well as significant and prolonged mental health problems, traumatic injury has been found to cause functional limitations and subsequent financial repercussions, in turn impacting an individual's quality of life, as well as that of their families (Sorberg, Bautz-Holter, Roise, & Finset, 2010; Steel, Dunlavy, Stillman, & Paper, 2011).

Prevalence studies have established that, when assessed during initial hospitalisation following the injury, rates of depression varied between 8 to 60%

(Bryant et al., 2010; Mason, Wardrope, Turpin, & Rowlands, 2002; Richmond et al., 2010; Steel et al., 2011), with longitudinal studies finding rates ranging between 6 to 42% at 6 to 12 months after injury (Bryant, 2011; O'Donnell et al., 2004; Steel et al., 2011). Prevalence rates of PTSD following traumatic injury have been reported in 18 to 42% of patients at 1 to 6 months post-injury (Steel et al., 2011), and 2 to 46% at 12 months post-injury (Bryant, 2011; O'Donnell et al., 2003; Quale, Schanke, Froslie, & Roise, 2009; Richmond et al., 2011; Schnyder, Moergli, Klaghifer, & Buddeberg, 2001; Zatzick et al., 2002). Prevalence rates for anxiety following traumatic injury have been less frequently documented, however, one larger-scale study (Bryant et al., 2010) found that rates of generalised anxiety disorder (GAD) 12 months after injury were reported in 10% of participants, agoraphobia in 7%, social phobia in 5% and panic disorder in 4% of the sample. Another study documented significant symptoms of anxiety in 13.8% of respondents at 6 months after injury (Mason et al., 2002), and a further study (Mayou, Bryant, & Ehlers, 2001) found a 19% prevalence rate at 12 months post-injury. However, whilst a review of the literature clearly establishes that negative mental health outcomes are a regular by-product of traumatic injury, the same literature only exhibits a very small number of studies have evaluated the overall patterns of specific trajectories of these mental health outcomes after injury.

Mental Health Trajectories after Traumatic Injury

Contrary to early assumptions of homogenous and negative stress responses, not all individuals appear to experience psychological distress after a traumatic event, and in fact, many remain psychologically healthy over the long-term. Bonanno and colleagues (2004; 2005; 2007) identified four prototypical mental health outcome patterns following traumatic events. Firstly, they established that some people were

overwhelmed and unable to function for years after the event (chronic dysfunction trajectory). Others experienced difficulties for months but returned to baseline levels of adjustment, demonstrating a pattern of acute distress with moderate to severe levels of initial symptoms and then improvement over time (recovery trajectory). A third group endured moderate levels of symptoms and distress that gradually and consistently worsened (delayed-onset trajectory). The final group was characterised by an ability to largely maintain functioning soon after the event with relatively low levels of distress (resilience trajectory).

These four trajectories have been identified after traumatic exposure in different samples including bereaved individuals (Bonanno, Moskowitz, Papa, & Folkman, 2005), breast cancer survivors (Deshields, Tibbs, Fan, & Taylor, 2006), threat of mass casualty due to terrorism (Hobfoll et al., 2009), spinal cord injury (Bonanno, Kennedy, Galatzer-Levy, Lude, & Elfstrom, 2012), motor vehicle accident survivors (Bryant, Harvey, Guthrie, & Moulds, 2000) and sexual assault victims (Koss & Figuerdo, 2004). Frequency analyses of both PTSD and depression indicate that resilience is by far the most common trajectory of the four types (Mancini & Bonanno, 2006) and is exhibited in 50-65% of cases after exposure to a traumatic event (Bonanno, 2005; Galea et al., 2002). A chronic trajectory pattern for depression was found in approximately 5-10% of single incident trauma survivors (deRoon-Cassini et al., 2010; O'Donnell et al., 2004). Interestingly, grief and bereavement research has been unable to identify delayed-onset distress in more than 2-3% of the total sample (Bonanno & Field, 2001). In contrast to this lack of evidence for delayed grief responses, delayed-onset for PTSD is evident in approximately 5-10% of individuals exposed to trauma (Andrews, Brewin, Philpott, & Stewart 2007; Bonanno, 2008;

Buckley, Blanchard, & Hickling 1996). Although, whilst frequency analysis has enabled the identification of prevalence rates for the different trajectories, as yet, in this body of literature, no studies have evaluated and compared the overall pathways of the most commonly exhibited mental health problems following trauma (notably, anxiety, depression and PTSD).

To date, only three published studies have specifically explored trajectories of mental health outcome after traumatic injury (Bonanno, 2012; deRoon-Cassini et al., 2010; Quale and Schanke, 2010). deRoon-Cassini et al. (2010) conducted a 6-month longitudinal study of 330 traumatically injured patients at four different time points after injury (hospitalisation, one month, three months and six months following hospitalisation), measuring Acute Stress Disorder (ASD), PTSD and depression. They found PTSD trajectories to reflect: resilience (reported by 59%), followed by chronic (22%), recovery (13%), and lastly delayed-onset (6%) pathways. Their results illustrated a slightly different pattern for depression; with rates suggesting again that whilst resilience is most common (60%), delayed-onset (17%) was second most common, followed by recovery (15%) and then chronic (10%) depression. deRoon-Cassini et al. (2010) however, did not measure non-PTSD anxiety in their study.

In the second trajectory study, Quale and Schanke (2010) investigated a 'general psychological distress' outcome (characterised by the presence of any symptoms of depression, anxiety and/or PTSD) in 80 individuals after severe spinal cord injury and/or multiple traumatic injuries. Comparable with de-Roon Cassini et al.'s (2010) study, a resilience trajectory was most common (evident in 54% of participants), followed by recovery (25%) and chronic patterns of distress (21%). Delayed-onset distress was not assessed. In the third trajectory study, Bonanno et al.

(2012) investigated the trajectories of depression and non-PTSD anxiety following spinal cord injury. Whereas de-Roon Cassini et al.'s (2010) study demonstrated a delayed-onset trajectory to be the second most common outcome for depression, after resilience, Bonanno et al.'s (2012) investigation found that a resilience trajectory followed by a recovery trajectory was the most common pattern for both anxiety (58.1% and 32.6% respectively) and depression (50.8% and 23.9% respectively). A chronic trajectory was evident in the depression outcome but rates did not reach statistical significance for anxiety; and finally delayed-onset was evident but the least common of all trajectories following both depression and anxiety.

The primary similarity between these three studies appears to be that resilience is the most common trajectory of any mental health outcome after traumatic injury. Methodological limitations were evident in each of the studies, which reduces the generalisability of their findings to a wider traumatically injured population or a comparison between mental health outcomes. In particular, the relatively acute assessment time points (hospitalisation, one-, three- and six-months following hospitalization) utilised in de-Roon Cassini et al.'s (2010) study are not necessarily conducive to understanding or demonstrating a (longer-term) chronic or delayed-onset pattern. Further, their study had a relatively large drop-out rate (36.4%) and used a predominantly homogenous sample comprising primarily of motor vehicle accident (MVA) survivors, further inhibiting the generalisability of the results for other injury populations. Bonanno et al.'s (2012) study addressed some of these limitations by using a longitudinal design with four time points (from baseline up to two years after injury), as well as a cross-cultural sample of participants from six countries. Despite these methodological strengths, the outcome measures comprised depression and

anxiety although excluded PTSD, and therefore a comparison of trajectories between each of the three mental health outcomes was not possible. Similarly, since Quale and Schanke's (2010) study relied on a general outcome measure of mental health, a delineation of, or comparison between the trajectories of depression, anxiety and PTSD was also not possible.

Sociodemographic Predictors of Mental Health Outcome

A further important area of investigation regarding mental health outcome following exposure to traumatic injury has been sociodemographic predictors. With regards to PTSD, the volume of studies implicating sociodemographic predictor variables is sound, noting female gender, younger age, lower income, limited social support and pre-injury exposure to trauma (Steel et al., 2011). Similarly, predictors of depression and anxiety after traumatic injury have been consistently found to include female gender, concomitant brain injury and pre-injury psychiatric history (Holbrook, Hoyt, Stein, & Sieber, 2001; Steel et al., 2011). However, there appears to be minimal research that directly evaluates the relationship of demographic variables with longitudinal mental health outcomes to a traumatic injury population; and/or their trajectory patterns. Moreover, there appears to be a dearth of studies comparing the impact of these well-established demographic variables between depression, anxiety and PTSD in a traumatically injured population. This line of investigation would extend both the current traumatic injury literatures and knowledge of predictive demographics.

In summation, a review of the literature in the traumatic injury domain has illustrated through prevalence studies that reduced mental health is a frequent and outcome following injury. Furthermore, the limited studies that have investigated the

typical trajectories of mental health outcomes (inclusive of broader 'general distress' measures) in the traumatic injury domain have demonstrated that, in line with Bonanno's (2004) model, the most commonly exhibited pattern of the four prototypical trajectories of distress is the resilience trajectory. The fact that there have been only a small number of published studies that directly evaluate mental health trajectories following traumatic injury suggests that more information in this domain would be beneficial in understanding the mechanisms underpinning those outcomes. Importantly however, no published study to date has explored and compared the trajectories of different mental health outcomes, specifically (non-PTSD) anxiety, depression and PTSD. Indeed, none of the three aforementioned injury studies examined the specific trajectories of these three mental health outcomes; and in fact the studies typically followed a specific mechanism or subtype of injury (for example; depression after spinal cord injury [Quale & Schanke, 2010]). Notably, a comparison of the trajectories of different mental health outcomes after traumatic injury has to be investigated. Exploring the overall pattern of the three mental health outcomes (depression, anxiety and PTSD) has the scope to inform clinical treatment by delineating symptom profiles and therefore informing differential schedules of intervention for each separate outcome. Additionally, the very few studies which have evaluated the trajectories of mental health outcome following injury have not examined the impact of demographic variables which have been well-established to correlate with mental health outcome after traumatic injury. A longitudinal study conducted with a large and representative sample of traumatically injured individuals with a direct comparison of the three mental health outcome measures (anxiety, depression and PTSD) would address these methodological limitations identified in the three aforementioned trajectory studies; and would extend our understanding of the impact of demographic factors on mental

health patterns. It would facilitate a clearer comprehension of the individual trajectories of depression, anxiety and PTSD after traumatic injury whilst also providing an overall (comparative) evaluation of the patterns and impact of mental health problems following traumatic injury; knowledge which has been called for within the field of rehabilitation psychology (White, Driver, & Warren, 2008) in order to minimise the long-term impact and burden of injury on the general population.

Aim of the Current Study

The primary aim of the current study was to evaluate and compare the differences in longitudinal trajectories of depression, (non-PTSD) anxiety and PTSD symptomatology over the initial 12 months following traumatic injury. Given the lack of studies that have specifically compared trajectories of these three common mental health outcomes following traumatic injury, an exploratory design was adopted for the purposes of this study.

The second aim of this study was to examine the impact of age, gender and psychiatric history on the trajectories of anxiety, depression and PTSD symptomatology after traumatic injury. The inclusion of demographic factors within the trajectories evaluation is warranted due to the body of literature associating these sociodemographic factors with mental health outcomes (Ozer et al., 2003; Steel et al., 2011; Holbrook et al., 2001). Although younger age, female gender and the presence of a psychiatric history would likely be predictive of worse levels of anxiety, depression and PTSD symptomatology; more pertinent to the current study is the influence of these factors for each of the three mental health outcome trajectories (rather than the impact on the extent of symptomatology). Given that few studies have focused directly on an evaluation of the impact of demographics on trajectory patterns following injury;

and of those that have, have explored an indirect relationship where no consistent pattern of impact has been established; it was anticipated that the inclusion of demographic variables in the current study would not moderate the observed trajectory patterns.

2.3 Method

Participants

Participants were recruited from admissions from four level 1 trauma hospitals in three states of Australia (Westmead Hospital, New South Wales; Alfred and Royal Melbourne Hospitals in Victoria; and Queen Elizabeth Hospital in South Australia). A random sample of patients was recruited from weekday trauma admissions over 23 months (13 March 2004 – 21 February 2006). Inclusion criteria included proficiency in English, age between 16 and 70 years, and an injury serious enough to require hospitalisation of more than 24 hours. Patients with mild traumatic brain injury (TBI; as defined by the American Congress of Rehabilitation Medicine [1993]) were eligible to participate; however those with severe or moderate TBI were excluded. Patients were further excluded if they were suicidal or psychotic, were non-Australian visitors/tourists or had cognitive impairment. Throughout the 2 year period, 3771 patients met inclusion criteria and 1593 participants were randomly selected using an automated, random selection procedure, stratified by length of hospitalisation. Random selection was used in preference to a consecutive design as the numbers of patients admitted exceeded the allocated recruitment processes. Of these 1593 potential participants, 1166 (73%) consented to be involved in the study, with complete intake data being collected on 1062 participants (91%) and 715 participants (71%) completing the 12 month follow-up assessment. The age of participants ranged from 16 to 71 years

(*M* = 37.75, *SD* = 13.67) and almost two-thirds of the sample reported having experienced a pre-injury psychiatric history at some point in their lives. The sample was comprised of 73.9% males (*n* = 811) and 26.1% females (*n* = 287). The mean number of injuries per person was 3.8 (*SD* = 2.54); and the mean Injury Severity Score (ISS) was 11.17 (*SD* = 8.01), which is in the moderate range of severity.

Reports from the original data set from the larger study (O'Donnell et al., 2013) indicated that individuals who refused to participate in the study did not differ from those who participated in terms of gender, length of hospital admission, injury severity or age. Patients who did not complete the 12 month assessment did not differ from those who did in regards to gender, length of hospitalisation or injury severity. However, non-completers were reportedly more likely to be younger.

Measures

Psychiatric History. The Mini International Neuropsychiatric Interview version 5.5 (MINI; Sheehan, Lecrubier, & Harnett-Sheehan, 1998) was used to measure lifetime history of major depression, dysthymia, panic disorder, social phobia, obsessive-compulsive disorder, PTSD, GAD, alcohol abuse and alcohol dependence. The MINI is a brief, structured diagnostic interview based on the DSM-IV and International Statistical Classification of Diseases and Related Health Problems – 10th Revision (ICD-10);and has sound reliability for each diagnosis (Sheehan et al., 1998). For the purposes of the current study, responses on the MINI were dichotomised such that the presence/absence of any psychiatric history was observed and incorporated as a predictor variable.

Posttraumatic stress symptoms (PTSD symptomatology). The Clinician Administered PTSD Scale (CAPS; Blake et al., 1995) was administered in the acute setting (1 week post-injury) and at 3 and 12 months post-injury. The CAPS, a widely used tool for the diagnosis of PTSD, has been found to have excellent reliability and validity (Weathers, Keane, & Davidson, 2001). Notably, PTSD symptoms in the acute setting were assessed excluding the 1-month time criterion; rather, a 'since you were injured' time criterion was incorporated. Telephone assessments (conducted at 3 months and 12 months post-injury) were recorded digitally to ensure consistency with the protocol. Inter-rater reliability was tested by having 5% of all CAPS interviews tested by an independent assessor (blinded to the original scoring), who reviewed recordings of the original diagnostic interview. The diagnostic consistency on the CAPS was found between assessors to be 0.97 at baseline, 1.00 at 3 months and 0.99 at 12 months post-injury. In the current study, CAPS was used as a continuous variable to measure posttraumatic stress symptom severity, rather than as a dichotomous variable of PTSD and represents the group average of the total CAPS score.

Anxiety and Depressive Symptoms. The presence and severity of depressive and anxiety symptoms was measured using the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) which is a self-report questionnaire that is suitable for injury populations as it does not measure somatic symptoms. The HADS has excellent discriminant validity and internal consistency as well as good factor structure (Bjelland, Dahl, Haug, & Neckelmann, 2002). The HADS scores were used in the current study as continuous variables to assess symptom severity.

Procedure

Ethical approval was provided by the human research ethics committee at each hospital and at the University of Melbourne for the original large scale study. Subsequently approval for the current study was provided by Macquarie University Human Research Ethics committee based upon use of the relevant measures for the program of research.

Following written consent, baseline assessments were conducted on average 7 days (*SD* = 7.8) after the initial assessment for injury for all eligible participants. The assessment comprised a structured clinical interview in which the CAPS and MINI were administered to assess the presence of posttraumatic stress symptomatology, and self-report questionnaires that also included the HADS. Interviews were conducted just prior to discharge when IV narcotic opiods had ceased. Some people were discharged on oral opiods and other pain medication. Characteristics of injuries were obtained from automated hospital-based registry systems and included injury severity score (ISS), length of hospitalisation, intensive care unit (ICU) admission and discharge destination. Participants were subsequently assessed at 3 months and 12 months post-admission, using the CAPS to assess PTSD symptom severity via telephone. They were also sent self-report questionnaires containing the HADS, which were returned in a reply-paid envelope.

Statistical Analyses

Means, standard deviations and frequencies were calculated using the Statistical Package for Social Sciences (SPSS) version 16 to identify the characteristics of the population and examine the prevalence rates of anxiety, depression and posttraumatic symptom severity and psychological history. There were 54 participants who did not

have identified injury. These scores were attributed to missing data and therefore disregarded in the analysis.

The main analyses were based on a linear mixed model, or multi-level model (Singer, 1998); in particular, a random intercept model. This method was selected as it could be fitted with maximum likelihood methods, thereby taking into account missing data in longitudinal datasets. Most importantly, it also allowed for individual differences in growth curves to be examined.

Missing data

A maximum-likelihood estimation using the incomplete data (Schafer & Graham, 2002) was selected as the appropriate mechanism to manage missing data. This method is contingent on the assumption that the data are missing at random (MAR); that is, missingness is random and independent of the data which has been collected. Plausible violations of the assumption would occur, for example, if a change in circumstances inhibited an individual's availability to complete the questionnaires at any of the time points. It is proposed here that this kind of change, though possible, would be a relatively unique reason for not taking part in the follow-up assessment, when compared with so many other possible reasons. Thus, in line with Schafer and Graham's (2002, p. 173) position that "failure to account of the cause [of missingness] seems capable of introducing only minor bias" and therefore meeting the assumption that data are missing at random, valid inferences could be made from our data using the maximum-likelihood method.

Composition of model

Random intercept linear mixed modelling was used to evaluate the trajectory of psychopathology over time. The participant variable was treated as a random factor. This meant that the between-subject variability of the multiple observations for each participant was represented by random variation of their mean (or, intercept scores) around a fixed intercept. Thus, the correlation amongst the values of the dependent variable (specifically depression, anxiety and PTSD symptom severity scores) that came from the same person could be assessed and incorporated into the analysis. The other random term reflected the variation of each subject's score on a particular measure at a given time around the mean of all their scores.

Specifically, the random intercept multi-level model included:

- *Level 1* – multiple observations of the dependent variables: depression, anxiety and PTSD symptom severity for each subject over time (Time 1 [T1] = baseline/admission; Time 2 [T2] = 3 months; Time 3 [T3] = 12 months)
- *Level 2* – age, gender and presence of psychiatric history.

The fixed terms for the intercept used in this initial model included age (at baseline, centred around the mean), gender (0 = male, 1 = female) and psychiatric history (0 = no history, 1 = any history). Time was treated as a categorical variable (T1, T2, T3) as any changes over time were expected to be non-linear. The selection of age, gender and psychiatric history as variables included in the model was based upon the consistent finding throughout the literature regarding their impact on mental health outcome after traumatic injury (O'Donnell et al., 2010; Ozer et al., 2003).

Since the random effects included in the model represented individual variation around the intercept, the model could thus be classified as a random intercept model. A

p value below .05 was considered to be statistically significant. Furthermore, effect sizes were calculated with a coefficient of determination analysis of variance (referred to as R2). This method was deemed most appropriate for the analysis because it applies equally to numeric and categorical variables and is suitable for models and variables.

2.4 Results

Descriptive Data

Descriptive data for the sample are presented in Table 1, which illustrates the characteristics of the sample of injury patients, including gender, age and psychiatric history. 1098 injury survivors who met inclusion criteria (after excluding *n* = 14 missing cases) with an age of participants from 16 to 71 years (*M* = 37.75, *SD* = 13.67).

Table 1

Characteristics of the Sample of Injury Patients

Variable		N	% of sample	*M*	*SD*
Gender					
	Male	811	73.9	-	-
	Female	287	26.1	-	-
Age					
	Total sample	-	-	37.75	13.67
	Female	-	-	39.13	14.29
	Male	-	-	37.26	13.98
Psychiatric History					
	MINI (y)	665	62.1	-	-

Note. MINI = Mini International Neuropsychiatric Interview**;** 'y' = presence of the specific variable, presence of psychiatric history.

Mental Health Outcome

Patterns of mental health outcomes across the three time periods are illustrated in Table 2. The Overall Sample *n* for each outcome demonstrates the use of the stacked dataset, reflecting the total number of incidents (that is; from each of the three time points combined). It was therefore approximately three times the number of participants involved. The most commonly reported mental health outcome was PTSD symptoms (86.7% of the sample), with equal distribution between anxiety and depression (79.9% respectively). Additionally, clinical cut-off rates for each respective disorder were not utilised as part of the study (in favour of symptomatology measures), however prevalence rates of clinical disorders were as follows at Time 2: anxiety disorders (33.7%), Major Depressive Disorder (17%) and PTSD (9.64%). At Time 3, the prevalences were as follows: anxiety (33.7%), Major Depressive Disorder (16.28%) and PTSD (9.67%).

Table 2

Mental Health Outcomes of the Sample of Injury Patients at Baseline, Admission, 3 Months and 12 Months after Traumatic Injury

Outcome Measure	*N*	%	*M*	*SD*
HADS-Anxiety				
Overall	2666	79.9	2.12	1.07
Time 1	999	-	2.03	1.04
Time 2	874	-	2.14	1.08
Time 3	793	-	2.21	1.09
HADS-Depression				
Overall	2665	79.9	1.91	1.05
Time 1	999	-	1.96	1.02
Time 2	874	-	1.95	1.02
Time 3	792	-	1.80	1.11
CAPS-PTSD Symptomatology				
Overall	2893	86.7	3.75	2.29
Time 1	1087	-	3.79	1.98
Time 2	952	-	3.88	2.93
Time 3	854	-	3.56	2.25

Note. Anxiety and Depression = Hospital Anxiety and Depression Scale; PTSD = Clinician Administered PTSD Scale (Time 1 symptomatology measured within seven days of injury; CAPS scoring rule Frequency = 1, Intensity = 2); *n* = number of participants who endorsed symptomatology of that outcome measure; % = percentage of overall sample who endorsed one or more symptoms of that outcome measure at any time point.

Preliminary modelling. Preliminary analyses using mixed modelling were conducted to ascertain the delineated trajectories of anxiety, depression and PTSD symptomatology averaged across the sample. These analyses revealed (independent of demographic variables) significant effects of injury on anxiety, depression and PTSD symptom severity respectively; such that, across the sample of injured participants, the severity of each of the mental health outcomes changed significantly across time (see Table 3 and Figures 1-3). Figures 1 - 3 illustrate the changes in symptom level of each mental health outcome across the three observed time points: baseline, 3 months and 12 months after traumatic injury, averaged across the sample.

Table 3

Mean and Standard Errors of Anxiety, Depression and PTSD Symptomatology at Admission, 3 Months and 12 Months Following Traumatic Injury

Variable	Anxiety		Depression		PTSD	
	M	*SE*	*M*	*SE*	*M*	*SE*
Time 1	2.05	0.036	1.98	0.030	3.90	0.075
Time 2	2.19	0.040	1.96	0.040	4.02	0.078
Time 3	2.26	0.040	1.82	0.040	3.76	0.080

Note. Anxiety = HADS Anxiety score; Depression = HADS Depression score; CAPS = Clinician Administered PTSD Scale; Time 1 = Admission, (within 7 days of injury); Time 2 = 3 months post-injury; Time 3 = 12 months post-injury.

Figure 1 indicates that anxiety changed significantly over time, increasing at a non-linear rate over 12 months after traumatic injury, $F(2, 1655.45) = 17.67$, $p = .00$. However, the coefficient of determination effect size ($r^2 = 0.00$) suggested a low

clinical significance. Anxiety was reported to be statistically significantly higher at Time 2 compared with Time 1 (mean difference = 0.14, *SE* = 0.04); and at Time 3 compared with Time 2 (mean difference = 0.21, *SE* = 0.04). Analysis of the means at each time point (see Table 3) aligned the anxiety trajectory with a delayed-onset pattern.

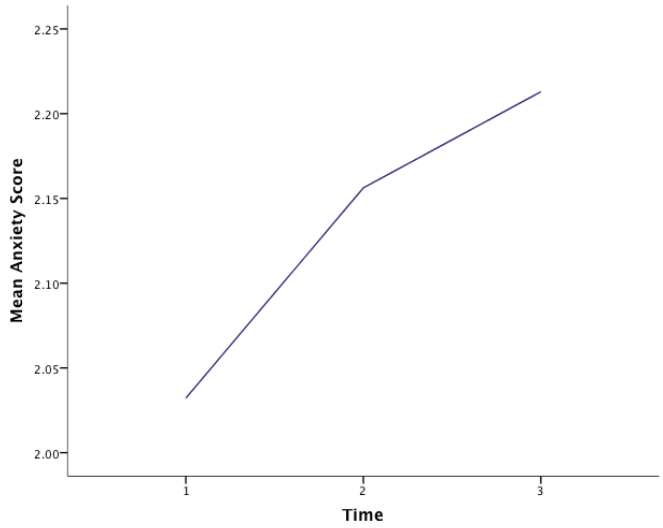

Figure 1. Main effect of anxiety on time.

Figure 2 indicates that depression changed significantly over time, decreasing at a non-linear rate over 12 months after traumatic injury, $F(2, 1679.57) = 9.98$, $p = .00$. However, the coefficient of determination effect size ($r^2 = 0.00$) suggested a low clinical significance. Levels of depression decreased slightly from Time 1 to Time 2, then notably from Time 2 to Time 3, ending at levels lower than baseline/Time 1. Depression was reportedly significantly higher at Time 1 compared with Time 3 (mean difference = 0.16, *SE* = 0.04); and at Time 2 compared with Time 3 (mean difference = 0.15, *SE* = 0.04). Analysis of the means at each time point (see Table 3) aligned the depression trajectory with a recovery pattern.

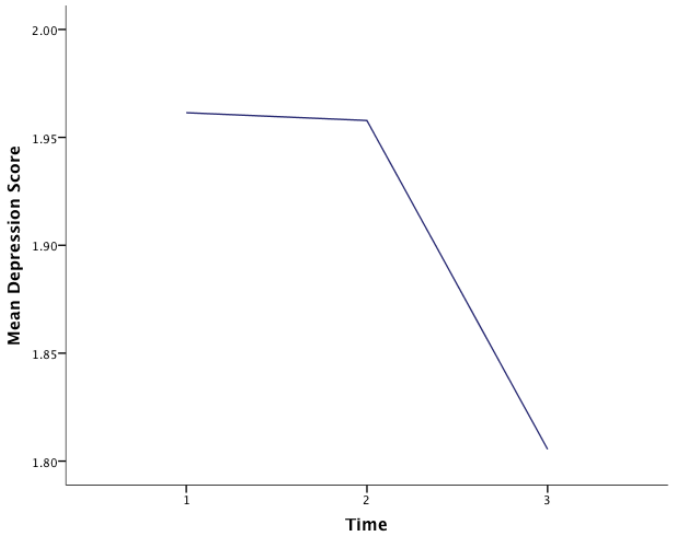

Figure 2. Main effect of depression on time.

Figure 3 indicates that the levels of PTSD symptom severity changed significantly over time, $F(2, 1816.25) = 7.15$, $p = .00$, (however, the coefficient of determination effect size ($r^2 = 0.00$) suggested a low clinical significance). Specifically, PTSD symptoms increased marginally from Time 1 to Time 2; then decreased from Time 2 to Time 3, ending at levels below baseline/ Time 1. PTSD symptoms were reportedly significantly higher at Time 2 than Time 1 (mean difference = 0.14, *SE* = 0.07); and at Time 2 than Time 3 (mean difference = 0.26, *SE* = 0.07). Again, analysis of the means at each time point (see Table 3) aligned the trajectory with a recovery pattern.

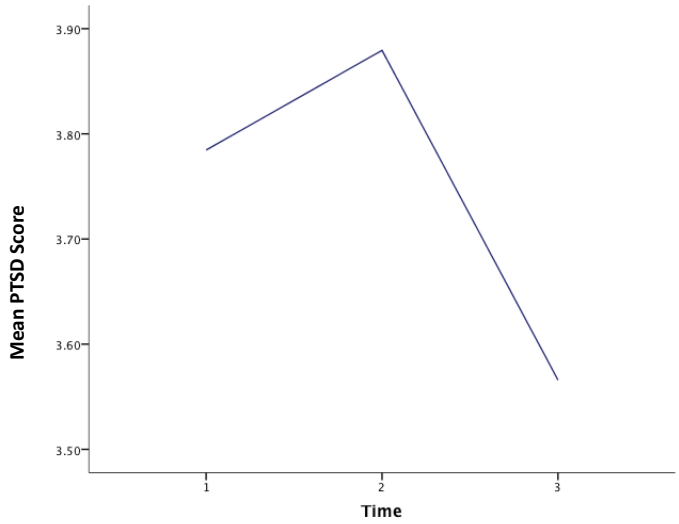

Figure 3. Main effect of time on PTSD Symptom Severity (PTSD symptom severity is indicated by the group average of the total CAPS score).

Primary modelling. Based upon the results of the preliminary modelling, and the emphasis in the literature on the association between demographic variables and mental health outcome, age, gender and the presence of a pre-injury psychiatric history were included as variables in the next stage of model development. This set of analyses included both the main effects of the variables (age, gender, psychiatric history) for each of the three mental health outcomes (depression, anxiety, PTSD symptom severity); the effects of the dependent variables on changes in the three mental health outcomes over time; and an evaluation of the interaction between demographic variables for each of the three mental health outcomes.

Main effect analyses revealed a significant main effect for psychiatric history across mental health outcomes (see Table 4). Specifically, individuals who reported having a pre-injury psychiatric history reported higher levels of anxiety (*M* = 2.43, *SE* = 0.04 vs. *M* = 1.89, *SE* = 0.05) ($r^2 = 0.00$), depression (*M* = 2.12, *SE* = 0.04 vs. *M* = 1.69, *SE* = 0.05) ($r^2 = 0.03$) and PTSD symptomatology (*M* = 4.48, *SE* = 0.08 vs. *M* =

3.26, *SE* = 0.11) ($r^2 = 0.06$ indicating a small effect size) than individuals who did not have a psychiatric history. Age was also significantly associated with anxiety (p = 0.01, r^2=0.00) and PTSD symptomatology (p = 0.00, $r^2 = 0.01$), such that younger participants reported higher levels of symptoms than older participants. There was no significant effect of age for depression symptom severity. Finally, females (*M* = 2.31, *SE* = 0.05) reported higher levels of anxiety than males (*M* = 2.01, *SE* = 0.03) (r^2=0.01). Similarly, females (*M* = 4.30, *SE* = 0.11) reported higher levels of PTSD symptoms than males (*M* = 3.44, *SE* = 0.07) (r^2=0.04, indicating a small effect size). No significant gender effects emerged for depression.

Table 4

Main Effects of Age, Gender and Psychiatric History on Anxiety, Depression and PTSD Symptom Severity

Variable	Anxiety			Depression			PTSD		
	F	*Df*	*p*	*F*	*df*	*p*	*F*	*df*	*p*
Gender	22.28	1, 985	.00**	3.62	1, 991	.06	42.86	1, 1028	.00**
Psychiatric History	71.75	1, 983	.00**	49.77	1, 988	.00**	83.18	1, 1027	.00**
Age	6.61	1, 985	.01*	0.18	1, 991	.68	15.71	1, 1035	.00**

Note. Anxiety = HADS Anxiety score; Depression = HADS Depression score; CAPS = Clinician Administered PTSD Scale.

* p< .05; ** p< .01

Given the significant main effects which emerged for each of three mental health outcomes over time, further analyses were conducted in this primary model, which included demographic characteristics. Results revealed a similar pattern to the preliminary findings: a significant main effect of time was evident for anxiety, $F(2, 1622.12) = 13.15$, $p = .00$; depression, $F(2, 1647.19) = 12.05$, $p = .00$; and PTSD symptoms, $F(2, 1773.71) = 7.69$, $p = .00$. Analyses of the pattern of means aligned with the trajectory patterns of the preliminary outcomes (see Figures 1 - 3) for each of depression, anxiety and PTSD symptomatology, which indicates that the inclusion of the three demographic variables within the model did not alter the trajectory patterns for each mental health outcome across time.

Two-and three-way interaction analyses were included in the modelling to evaluate interactions between the demographic factors of age, gender, psychiatric history and time for each of the independent variables. Analyses revealed a significant interaction between gender and age for anxiety, $F(1, 984.69) = 4.16$, $p = .04$ (see Figure 4). Older males and females reported similar levels of anxiety; whereas younger females reported higher levels of anxiety compared to older females, and compared to males of all ages. The level of anxiety reported by males did not differ significantly between ages. There were no significant three-way interactions between demographic factors, time and anxiety, nor did the interaction analyses between each of the demographic variables and time reach significance. This pattern suggests that age, gender and presence of a psychiatric history did not significantly alter the longitudinal trajectory of anxiety symptoms after traumatic injury.

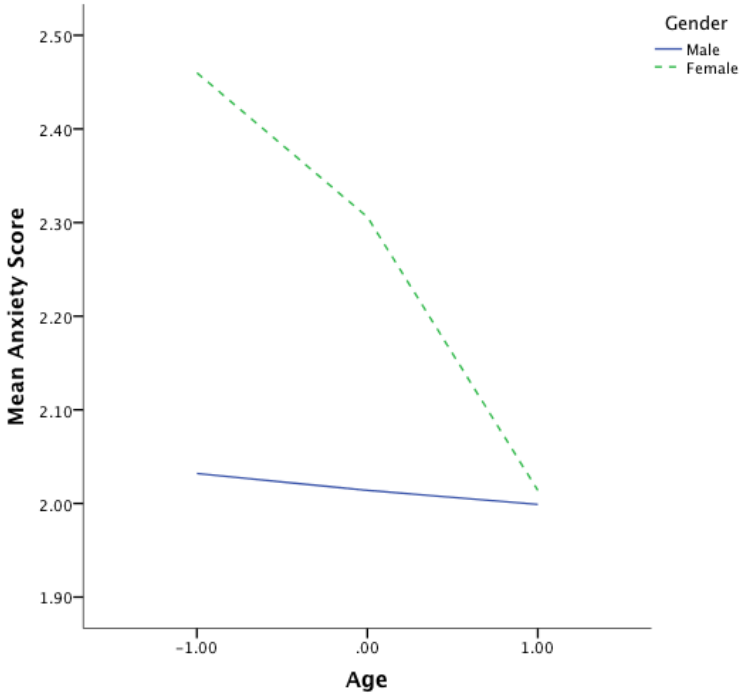

Figure 4. The significant interaction effect of Age X Gender on Anxiety. Age increases along the X-axis, with -1.00 representing 1 SD below the mean, .00 representing the mean and 1.00 representing 1 SD above the mean.

There were no two-way or three-way interactions involving any demographic variables with depression that reached significance, indicating that age, gender and psychiatric history did not alter the previously observed trajectory pattern. For PTSD symptomatology, analyses revealed a significant interaction between time and gender, $F(2, 1773.59) = 3.08$, $p = .04$. Specifically, females reported significantly higher PTSD symptomatology levels than males at each time point (see Figure 5). Additionally, the rate of recovery between Time 1 and Time 2, and between Time 2 and Time 3, differed between males and females. Although the rate of change differed between genders, an analysis of the trajectory pattern for each gender indicated a Recovery trajectory pattern. This result indicated that despite the interaction reaching significance,

demographic factors do not significantly alter the overall trajectory shape or pattern over time for PTSD symptoms.

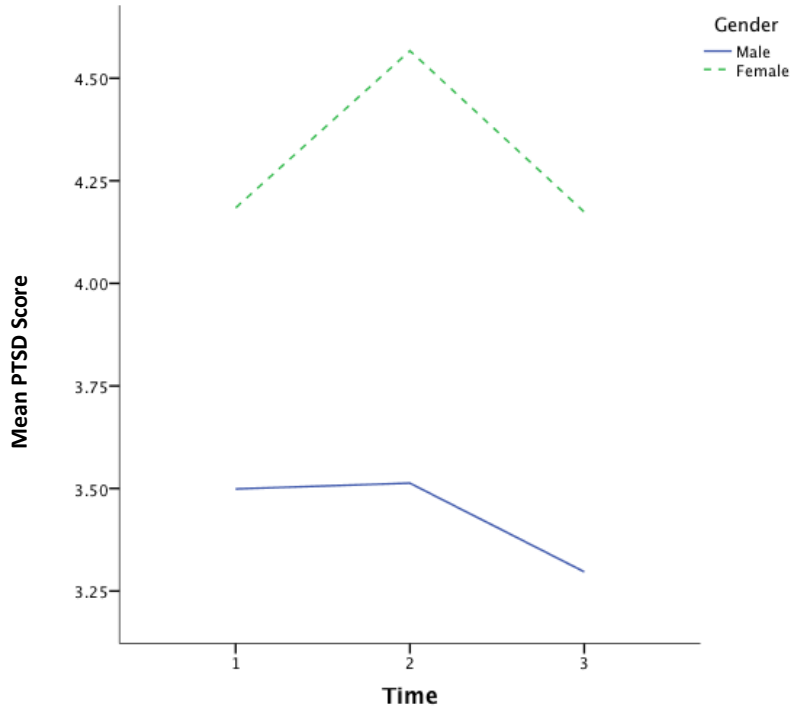

Figure 5. The significant interaction effect of Gender X Time on PTSD Symptomatology. PTSD is represented by mean CAPS score.

A significant effect was found between age and gender on PTSD symptoms, $F(1, 1034.54) = 7.45$, $p = .00$ (see Figure 6). Females of all ages reported higher PTSD symptomatology than males of all ages; older individuals reported less PTSD symptomatology than younger individuals, irrespective of gender; and the levels of PTSD symptomatology for females of increasing age reduced at a greater rate than for males of increasing age. Similarly to previous results, these analyses indicate that females exhibited higher PTSD symptomatology than males. In addition, the non-significant interaction between age and time suggests that age did not significantly alter the longitudinal trajectory of PTSD symptomatology after traumatic injury.

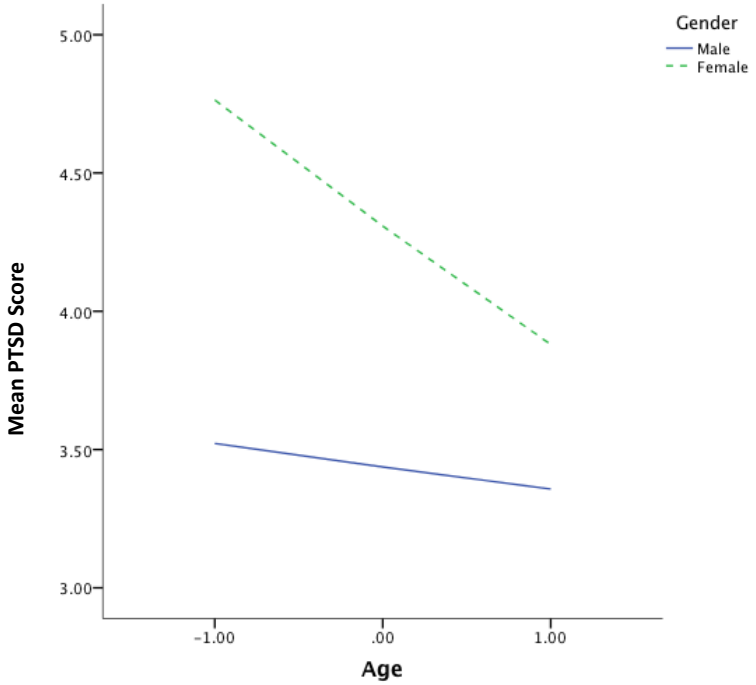

Figure 6. The significant interaction effect of Age X Gender on PTSD Symptomatology. Age increases along the X-axis, with -1.00 representing 1 SD below the mean, .00 representing the mean and 1.00 representing 1 SD above the mean. PTSD symptomatology is represented by mean CAPS scores.

Interaction analyses (see Figure 7) revealed a significant effect of gender and psychiatric history for PTSD symptoms, $F(1, 1025.68) = 9.97$, $p = .00$. Specifically, whilst males report lower PTSD symptomatology than females irrespective of the presence of psychiatric history, males with a psychiatric history reported higher PTSD symptomatology compared to males without a psychiatric history. A similar pattern was observed for females. Notably, females with no psychiatric history reported lower PTSD symptomatology compared to females with a psychiatric history. Furthermore, the differences between the levels of PTSD symptomatology for males compared to females were larger within the grouping of participants with a psychiatric history, than

those without a psychiatric history. Again, these results indicate that female gender and participants with a psychiatric history exhibited higher levels of PTSD symptomatology.

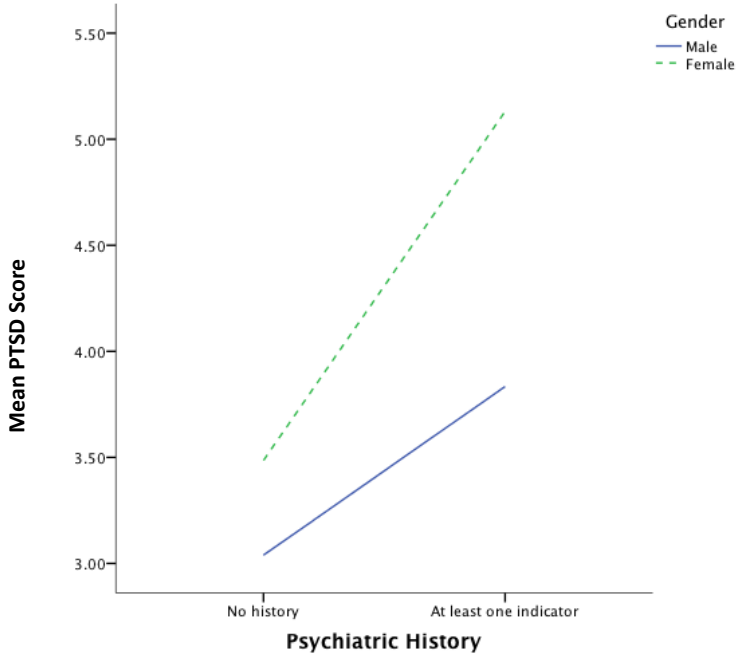

Figure 7. The significant interaction effect of Gender X Psychiatric History on PSTD Symptomatology. PTSD symptom severity is represented by mean CAPS scores.

Reduction modelling. Reduction modelling was conducted subsequent to the preliminary and primary modelling in order to iteratively remove the non-significant interactions from the highest to lowest order interactions. In this way, the reduced models for each dependent variable (depression, anxiety and PTSD symptomatology) would be derived to extract the demographic variables and appropriate main effects that would warrant retention in future analyses.

The final reduced model focusing on anxiety demonstrated significant main effects of time, age, psychiatric history and gender (see Table 5), with the coefficient of determination effect size value for the final model (r^2=.07) suggesting a small-medium

clinical significance. There were no significant interactions that remained after the iterative reduction process. The main effects are consistent with those of the non-reduced/primary model, whereby a significant Gender X Age interaction was found (see Figure 4). This overall pattern of results suggests that the demographic variables (age, gender, psychiatric history), as well as time, should be retained in future analyses of traumatic injury with anxiety.

Table 5
Significant Main Effects Derived from Reduction Modelling on Anxiety

Variable	*F*	*Df*	*p*
Time	17.36	2, 1640	.00**
Gender	24.04	1, 990	.00**
Age	6.26	1, 981	.01*
Psychiatric History	83.81	1, 984	.00**

Note. * $p < .05$; ** $p < .01$.

For depression, the final reduced model demonstrated significant main effects of gender, psychiatric history and time (see Table 6), with the coefficient of determination effect size for the reduced model (r^2=0.04) suggesting a small clinical significance. There were no interactions that reached significance after the iterative reduction process. This lack of significant interactions is consistent with the pattern of results from the equivalent primary modelling; and the main effects are also similar to the primary modelling results for depression, with the addition of a significant main effect observed for gender on depression following the reduction process. Specifically, females reported higher depression levels after traumatic injury than males. This overall pattern of results suggests that the demographic variables of age, gender, and

psychiatric history, as well as time, should also be retained in future analyses of traumatic injury with depression.

Table 6

Significant Main Effects Derived from Reduction Modelling on Depression

Variable	*F*	*Df*	*p*
Time	10.85	2, 1667	.00**
Gender	4.39	1, 991	.04*
Psychiatric History	53.78	1, 992	.00**

Note. * $p < .05$; ** $p < .01$.

The final reduced model focusing on PTSD symptomatology demonstrated significant main effects of time, age, psychiatric history and gender (see Table 7), with the coefficient of determination effect size (=.09) suggesting a small-medium clinical significance. Significant interactions were observed after model reduction for Time X Gender, Gender X Age and Gender X Psychiatric History. Both the main effect and significant interaction patterns of results were consistent with those results from the non-reduced/primary model. These results warrant the retention of the demographic variables (age, gender, psychiatric history), time and concordant interactions in future analyses of traumatic injury with PTSD symptomatology.

Table 7

Significant Main Effects and Interactions Derived from Reduction Modelling on PTSD Symptomatology

Variable	*F*	*df*	*p*
Time #	7.8	2, 1786	.00**
Gender #	42.72	1, 1029	.00**
Age #	16.86	1, 1028	.00**
Psychiatric History #	80.77	1, 1021	.00**
Time X Gender ##	3.21	2, 1786	.04*
Gender X Age ##	6.44	1, 1028	.01*
Gender X Psychiatric History ##	8.93	1, 1021	.00**

Note. # = Main effect analysis; ## = Interaction analysis; *$p < .05$; **$p < .01$

The reduced modelling results did not reveal any additional significant interactions between demographic variables and time, for any of the three mental health outcomes. This suggests that there was no difference in trajectory pathways for depression, anxiety and PTSD symptomatology that occurred between the primary and reduced modelling. As such, the overall trajectory patterns identified in the preliminary analyses were observed to be replicated and therefore did not require the inclusion of demographic variables in any subsequent re-modelling. The consistent significant main effects of demographic variables observed in the reduced modelling, however, indicates that any future modelling analysis using additional injury variables would benefit from the inclusion of these noted demographic factors.

Post hoc analyses. Given the significant changes observed throughout the preliminary modelling of the trajectories of each of the dependent variables (depression, anxiety and PTSD symptomatology) over time, further mixed modelling was conducted to evaluate the differences between the trajectories of each of the mental health outcomes.

A new dataset was therefore created with standardised outcome measures. Multiple observations (Time 1 [baseline], Time 2 [3 months post-injury] and Time 3 [12 months post-injury]) and the three outcome measures (anxiety, depression and PTSD symptom severity) were used for each participant. Since the initial scores of each outcome differed according to their measure (that is, HADS scores were initially used for anxiety and depression whereas CAPS scores were used for PTSD symptom severity), scores from measures were subsequently stacked and standardised prior to analysis of the model. Due to this standardisation within each person, the mean for subjects was zero, there was no between-subject variance, and no clustering effect (rho, the intraclass correlation coefficient, was zero). Therefore, there was no requirement for a random intercept factor to be included in the model (as was used to analyse the initial data).

Interaction analysis revealed a significant interaction of Time X Outcome Measure, $F(4, 7453) = 21.94$, $p = .00$; indicating that the trajectories of depression, anxiety and PTSD symptom severity changed differently across time. Detailed analysis of interaction contrasts revealed a significant difference between anxiety and depression in the change between Time 1 and Time 2, $F(4.19, 7453)$, $p = 0.00$; a significant difference between anxiety and PTSD symptomatology in the change between Time 1 and Time 2, $F(2, 7453) = 2.84$, $p = .00$; and a significant difference between anxiety and depression in the change between Time 1 and Time 3, $F(2, 7453) = 8.62$, $p = .00$. Interaction contrasts also revealed a significant difference between anxiety and PTSD symptomatology in the change between Time 1 and Time 3, $F(2, 7453) = 7.47$, $p = .00$; a significant difference between anxiety and depression in the change between Time 2 and Time 3, $F(2, 7453) = 4.49$, $p = .00$; and a significant

difference between anxiety and PTSD symptomatology in the change between Time 2 and Time 3, $F(2, 7453) = 4.67$, $p = .00$. Figures 8 and 9 illustrate that anxiety increased in a non-linear trend over time; depression decreased in a non-linear trend over time and PTSD symptom severity increased to a peak at Time 2 then decreased to below initial levels at Time 3.

In addition, simple effects analyses revealed a significant effect of Mental Health Outcome within Time 1, $F(2, 7453) = 19.58$, $p = .00$; and Time 3, $F(2, 7453) = 23.94$, $p = .00$. Specifically, pairwise comparisons indicated that at Time 1 (baseline), depression was significantly higher than anxiety (mean difference = 0.23, $SE = 0.04$) and PTSD symptom severity was significantly higher than anxiety (mean difference = 0.18, $SE = 0.04$). At Time 3 (12 months after injury), anxiety was significantly higher than depression (mean difference = 0.26, $SE = 0.04$) and anxiety was significantly higher than PTSD symptom severity (mean difference = 0.23, $SE = 0.04$; see Figure 8).

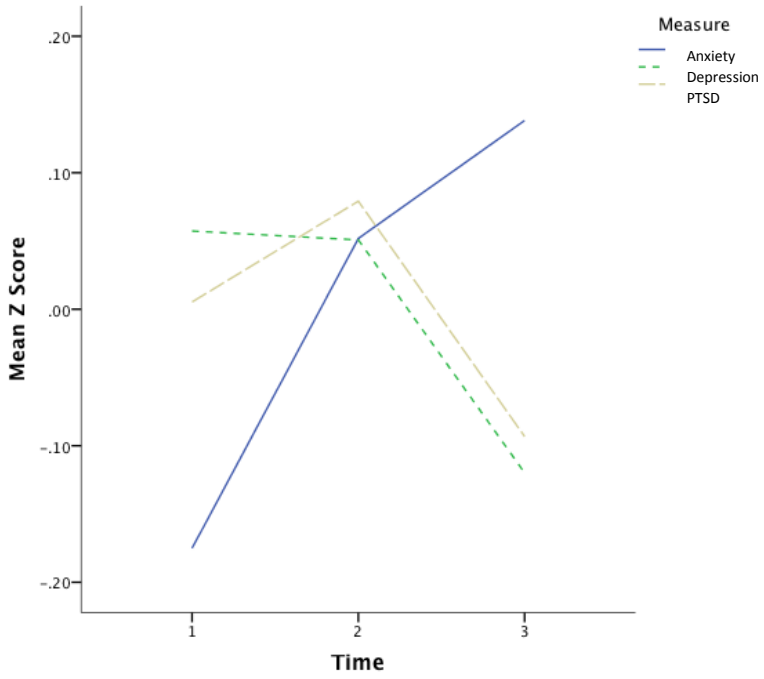

Figure 8. The significant interaction effect of Time X Outcome Measure. Measure scores are standardised scores derived from HADS and CAPS.

Further, the simple effects analyses revealed a significant effect of Time within each Mental Health Outcome; anxiety, $F(2, 7453) = 32.88$, $p = .00$; depression, $F(2, 7453) = 12.19$, $p = .00$; and PTSD symptom severity, $F(2, 7453) = 10.36$, $p = .00$. Specifically, pairwise comparisons indicated that anxiety levels were significantly greater at Time 2 than at Time 1 (mean difference = 0.23, *SE* = 0.04), at Time 3 than at Time 1 (mean difference = 0.31, *SE* = 0.04), and at Time 3 than at Time 2 (mean difference = 0.09, *SE* = 0.04). Analysis of the means at each time point (T1: -0.18; T2: 0.05; T3: 0.14) aligned the anxiety trajectory with a delayed-onset pattern, rather than a resilience trajectory (see Figure 9).

The pairwise comparisons also indicated that depression levels were significantly higher at Time 1 than at Time 3 (mean difference = 0.18, *SE* = 0.04), and at Time 2 than at Time 3 (mean difference = 0.17, *SE* = 0.04). Analysis of the means at each time point (T1: 0.06; T2: 0.05; T3: -0.12) aligned the depression trajectory with a recovery pattern (see Figure 9).

Lastly, pairwise comparisons indicated that PTSD symptom severity scores were significantly higher at Time 2 than at Time 1 (mean difference = 0.07, *SE* = 0.04), at Time 1 than at Time 3 (mean difference = 0.1, *SE* = 0.04) and Time 2 than Time 3 (mean difference = 0.17, *SE* = 0.04). Again, analysis of the means at each time point (T1: 0.01; T2: 0.08; T3: 10.09) aligned the trajectory with a recovery pattern (see Figure 9).

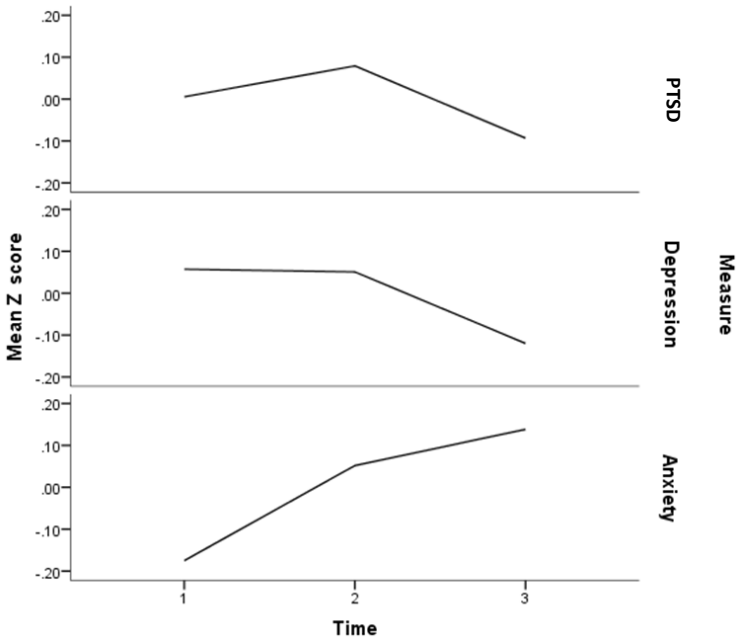

Figure 9. A comparison of the significantly different trajectories of depression, anxiety and PTSD symptom severity. Measure scores are standardised scores derived from HADS and CAPS.

2.5 Discussion

The primary objective of the current study was to investigate the overall trajectory pattern of three mental health outcomes following traumatic injury. Two questions were investigated: a comparison of the individual trajectories of anxiety, depression and PTSD symptom severity over the 12 month period following injury; and an exploration of the impact of age, gender and psychiatric history on those trajectory patterns.

The findings indicated that the course of anxiety symptoms resembled a delayed-onset trajectory, characterised by moderate to elevated symptoms soon after the injury/activating event and a gradual worsening over time. In contrast, a recovery pattern (characterised by elevated symptoms after the injury/activating event followed by a gradual return to normal or baseline levels) emerged for both depression and PTSD symptoms. Further, the specific trajectories for anxiety, depression and PTSD symptomatology were statistically significantly different to each other, despite the overall pattern of depression and PTSD symptomatology exhibiting the same general pattern of recovery. A means analysis of the recovery trajectories showed that, at Times 2 and 3, symptomatology was more severe for depression than PTSD, but less severe than PTSD symptomatology at Time 1. This result raises some interesting theoretical considerations for subsequent research; in particular the psychosocial mechanisms that might underlie both the similarities and differences between the recovery trajectory of depression and PTSD, and the delayed-onset trajectory of anxiety. This pattern might relate to co-morbidity issues that are noted in the trauma literature (Blanchard et al., 2004; Bryant et al., 2010; O'Donnell et al., 2004), notably the overlap between PTSD and Major Depressive Disorder.

Although the current research investigated the rate of adjustment for each of the three mental health outcomes (based on sample average), previous studies (Bonanno, 2012; de-Roon Cassini et al., 2010; Quale & Schanke, 2010) in a similar domain which evaluated the frequency of responses within each mental health outcome rather than a comparison between each outcome, had identified that the most common trajectory after trauma was a resilience trajectory. Interestingly, the current findings did not demonstrate any concordance with this outcome. This might be attributed to two important factors: firstly, that our research paradigm evaluated the overall trajectory for each outcome rather than using a latent class approach to explore the number of different observable trajectories within each mental health outcome; whereas our project focused on identifying a sample-averaged trajectory for each outcome that was subsequently compared to the other mental health outcomes. Secondly, results from the current study may in part be reflective of the heterogeneity and nature of the traumatic injury sample. A consistent pattern within the trajectory literature is the use of homogenous or restricted samples; a sample derived from (for example) motor vehicle accident survivors (Bryant et al., 2000) or breast cancer survivors (Deshields et al., 2006). Indeed, even within the three acknowledged studies focusing on a traumatically injured population, the investigated samples were restricted sub-samples: spinal cord injury survivors (Bonanno et al., 2012; Quale & Schanke, 2010); and/or multiple traumas (de-Roon Cassini et al., 2010). In contrast, the present findings are based on a larger sample size comprised of participants who reported a broader range of traumatic injuries which suggests a greater generalizability of results, but may also explain the dissonance with previous work which identified the preponderance of the resilience trajectory. On the basis that the current study is the first to provide a general comparative profile of the patterns of outcomes of mental health following traumatic

injury, it therefore acts as a starting point into the further identification of specific and comparative trajectories of mental health outcomes following traumatic injury. Thus, future investigation into the current theoretical and/or conceptual models, such as the transdiagnostic model (Grant et al., 2008) and/or comorbidity patterns (Barlow et al., 2004), may further facilitate in explaining our pattern of results, and accounting for the differences from previous traumatic injury work.

The second aim was to investigate the impact of age, gender and psychiatric history on the trajectory patterns pertaining to anxiety, PTSD and depressive symptom severity following traumatic injury. First, consistent with the literature (Holbrook et al., 2001; Ozer et al., 2003; Steel et al., 2011), results indicated that individuals with a psychiatric history had significantly elevated levels of anxiety, depression and PTSD symptomatology compared to individuals without a psychiatric history. Additionally, younger age and female gender were significantly associated with elevated anxiety and PTSD symptomatology, however, this pattern of findings did not emerge for depression symptoms. Notwithstanding the fact that age and gender did not reach statistical significance for depression, a means analysis indicated that the direction of the results was consistent with expectations (Holbrook et al., 2001; Steel et al., 2011). Note, however, that the effect sizes from main effect analyses remained low throughout all results. When combined with the results of the other mental health outcomes, this indicates that overall, younger age, female gender and the presence of psychiatric history are associated with more severe depression, anxiety and PTSD symptoms following traumatic injury. Pertinent to the direct aims of the study, however, was an examination of the influence of these sociodemographic variables on the trajectory patterns. Results were consistent with the expectation that age, gender and psychiatric

history would not change the observed trajectory patterns for each of the three mental health outcomes (that is, a delayed-onset trajectory), depression (recovery trajectory) and PTSD symptomatology (recovery trajectory). This highlights the robustness of the observed trajectories.

The pattern of trajectory findings may be consistent with cognitive theories of trauma and processing, such as Ehlers and Clark (2000), in which it is argued that the role of negative appraisals of the precipitant event (in this case, injury) and its sequelae, influence poor adjustment. For example, a person who interprets their initial emotional response after a traumatic injury as a 'normal' response to such an event, may be much less distressed than a person who appraises their initial emotional response as an indicator of an unsafe world; or of a perception that they 'attract' disaster. This negative interpretation accords with the finding that posttrauma symptoms which are interpreted as signals of impending deterioration, predict subsequent PTSD (Dunmore, Clark & Ehlers, 2001). Furthermore, traumatic events that leave the individual with permanent health problems are much more likely to lead to black and white appraisals (such as 'my life is over') than traumatic events which have a strong recovery prognosis (Ehlers and Clark, 2000). Within this framework of cognitive psychological theory, the recovery patterns observed in the current study for PTSD and depression suggest that participants utilised adaptive and realistic cognitive attribution styles incorporating stable world belief systems and schemas.

Under this same theoretical framework, the linear increase observed in the anxiety trajectory might be reflective of the maladaptive cognitive coping strategies including avoidance. It is common for individuals affected by a potentially traumatic event (such as injury) to avoid stimuli that initiate memories of the event (Ehlers and

Clark, 2000; Ozer et al., 2003). This attempted avoidance serves only to increase the individual's overall levels of anxiety and arousal. Emotional Processing Theory (Foa and Rothbaum, 1999) posits that this avoidance of stimuli inhibits habituation of fear, and that this pathological fear of the memories (as fear-provoking stimuli of the injury) can lead to avoidance, which in turn can result in an increase of re-experiencing and arousal symptoms. It is probable that the linear increase in anxiety observed in the current study, is reflective of this process.

Clinically, the results from this study have implications for current practice. The observed trajectory patterns for each mental health outcome highlights the value of initial screening for symptomatology for all mental health outcomes. Then, subsequently, the early intervention and treatment for individuals who exhibit anxiety symptomatology (specifically) following injury; and monitoring and intervention where appropriate for depression and PTSD. Since a delayed-onset pattern for anxiety is not immediately evident after the injury, screening for anxiety symptoms would be beneficial not only during the initial hospitalisation period, but either an additional follow-up screening should occur approximately three months after injury in order to identify this pattern (Bisson & Cohen, 2006), or ongoing monitoring of the symptoms should be conducted during physical rehabilitation treatment sessions. Furthermore, given the anxiety pattern indicates a gradual worsening of symptoms over time and therefore no natural remission, it would be prudent that once anxiety symptomatology has been identified, treatment options are discussed and implemented with the individual as soon as practically possible in order to enable the best chances of recovery (Barlow 2014; O'Donnell et al., 2012). Research indicates that early intervention treatment effectively reduces the likelihood of developing specific

psychiatric disorders (Bryant et al., 2003; Ehlers et al., 2003); and a recent review of meta-analyses of treatment efficacy by Hofmann, Vonk, Fang, Asnaani, and Sawyer (2012) showed consistent medium to large effect sizes for Cognitive Behaviour Therapy or variants thereof, across the breadth of anxiety disorders irrespective of the heterogeneity of specific anxiety pathology. Therefore, the current results suggest that since there is no natural reduction in anxiety symptomatology, the identification and implementation of effective anxiety treatment is likely to make a sound contribution to reducing the overall and social and financial burden of traumatic injuries. Furthermore, whilst the trajectories of depression and PTSD exhibited a reduction of symptomatology over time, the presence and extent of each outcome still highlights the value of early screening and intervention (where appropriate), in order to minimise any secondary psychosocial difficulties. It should also be noted that whilst immediate intervention (as distinct to screening for symptomatology) following exposure to a potentially traumatic event has not been found to be efficacious (Bisson & Cohen, 2006; Ozer at al., 2003), the provision of intervention in the weeks following the event has shown benefit.

Several methodological shortcomings of the current study should be mentioned, as they have the potential to limit generalisability of findings. The findings were based on a mixture of clinical interview (for PTSD symptom severity) and self-report (for anxiety and depression), leaving the data open to possible response and presentation bias. Additionally, given that a clinical interview is generally considered the gold standard of assessment (O'Donnell et al., 2003; Ozer et al., 2003) its inclusion for each of the mental health outcomes could have increased confidence in results and provided further standardisation of measurement indices. Notwithstanding this, the nature of the

parent data set utilised within this study led to a reliance on the HADS for measurement of depressive and anxiety symptoms. Use of the HADS has been increasingly criticised for structural, conceptual and psychometric problems within the instrument (Coye & van Sonderen, 2012). Specific criticisms include findings of different factor solutions in different populations (Cosco, Doyle, Ward, & McGee, 2012), inadequate sensitivity for major depression (Brennan, Worrall-Davis, McMillan, Gilbody, & House, 2010) and a potential impact from the exclusion of somatic symptoms of emotional distress (Annunziata, Muzzatti, & Altoe, 2011). These latter two points may be the most pertinent to the current results, particularly noting the non-significant results for age and gender with depression. It may be the case that the current results are reflective of the limitations of the depressive subscale in the HADS, which has been criticised for ambiguity regarding its definitional clarity of levels of negative affect (Coyne & van Sonderen, 2012). Regardless, the inclusion of a second instrument or clinical interview to capture depressive and anxiety symptomatology could more easily delineate whether the results are reflective of somatic exclusion, limitations of the depressive subscale, or are an accurate representation of symptomatology.

Furthermore, the study excluded patients with moderate or above TBI due to the nature of the present dataset. Irrespective of the fact that research has regularly identified an overlap between TBI and PTSD symptomatology (O'Donnell et al., 2003) and TBI has been found impacting reliability of self-report scales for patients (McMillan 2001) the exclusion of participants with levels of TBI higher than mild, may affect the generalisability of the results to broader injury populations that are inclusive of TBI patients.

In terms of predictor variables, neither social support nor socioeconomic status were reported. In particular, social support has been well established as a predictor and a correlation of post-traumatic adjustment (Ozer et al., 2003) and thus its inclusion may have provided greater depth to the results. Future work should include both variables to extend the current findings and potentially elicit additional patterns of results. Lastly, psychiatric history (as a demographic predictor) was dichotomised for the analyses. Whilst this afforded simplicity in focusing on the project aims, this very same simplicity limits an understanding of whether differences in (for example) anxiety versus an affective disorder affected the impact or mental health outcome.

The identified studies that have examined, (although not compared) mental health outcomes following traumatic injury, have typically employed the latent growth mixture models (LGMM) method for identification of discrete trajectories (Bonanno et al., 2012; de-Roon Cassini et al., 2010). This method tests for the presence of multiple classes of individuals that represent distinct multivariate normal distributions. The subsequent groups of populations are modelled using categorical latent variables (classes) in combination with continuous latent variables that define a particular growth trajectory with each class which then enables curvilinear and quadratic functions. However, this was not utilised within the current study for two reasons; firstly because the research question required a comparison capability rather than detailed dissection of individual patterns; and secondly, because the nature of the parent dataset had provided three time points that were treated categorically, rather than the four time points that are required for LGMM (Jung & Wickrama, 2008). In this way, the use of LGMM to compare individual differences within each of the three mental health outcomes was beyond the scope of this current study. A next step for future work

within this domain would be to combine both approaches within the same study; that is, include both mixed modelling and LGMM in order to elicit a comparison of the trajectories between the three mental health outcomes; as well as investigate the sub-trajectories within each discrete outcome trajectory. This future combination study may well establish additional and/or unexpected trajectories within each overall mental health outcome. Such comparisons would provide further specificity to the underlying individual symptom profiles of depression, anxiety and PTSD symptom severity and in this way, inform the implementation of appropriate treatment paradigms, inclusive of the identification of appropriate timeframes to maximise treatment gains.

Despite its limitations, this study extends the empirical traumatic injury literature by its identification of the individual trajectories of depression, anxiety and PTSD symptom severity following traumatic injury, and its comparison of the patterns of mental health outcomes following injury. The key findings, that the trajectory of each mental health outcome is (statistically) significantly different from the others albeit exhibiting low clinical significance; that anxiety exhibits a delayed-onset trajectory whereas both PTSD symptoms and depression show a recovery trajectory; and that sociodemographic factors do not change these trajectories; provide a solid foundation for further research of the alignment of individual symptom profiles with conceptual models in order to elicit a greater understanding of the mechanisms of these differences. As noted, whereas previous literature has focused on the identification of trajectories within each mental outcome, the current research has extended this by being able to identify differences between the trajectories of each outcome. Furthermore, the use of a large sized heterogeneous traumatically injured sample in a prospective longitudinal design incorporating three different mental health outcomes,

facilitates higher generalisability of these results to the broader traumatically injured population.

In order to extend the findings of the current study, future work within the traumatically injured population could incorporate growth modelling to differentiate and further evaluate the trajectory analyses. Additionally, since both the current study and broader literature have consistently highlighted a predictive relationship of sociodemographic factors with reduced mental health outcomes, further exploration of predictor variables is warranted. For example, an exploration of the role of injury-specific characteristics (such as site and severity of injury) as predictors of each mental health outcome across time, would add greater depth to our understanding of the pattern and extent of, and determinants for, mental health outcomes following traumatic injury. Overall, the results from the current study support the implementation of screening for mental health symptomatology following traumatic injury; and the subsequent provision of appropriate intervention should symptomatology (particularly anxiety) be present. The findings also highlight the importance of ongoing monitoring of mental health symptomatology throughout the 12 months following injury.

2.6 References

American Congress of Rehabilitation Medicine. Definition of mild traumatic brain injury. *Journal of Head and Trauma Rehabilitation, 1993,* 8, 86-87.

Andrews, B., Brewin, C.R., Rose, S., & Kirk, M. (2000). Predicting PTSD symptoms in victims of violent crime: the role of shame, anger and childhood abuse. *Journal of Abnormal Psychology, 109,* 69-73.

Annunziata, M.A., Muzzatti, B., & Altoe, G. (2011). Defining hospital and anxiety depression scale (HADS) structure by confirmatory factor analysis: A contribution to validation for oncological settings. *Annals of Oncology, 22*(10), 2330-2333.

Barlow, D.H., Allen, L.B., & Choate, M.L. (2004). Toward a unified treatment for emotional disorders. *Behaviour Therapy, 35,* 205-230.

Barlow, D.H., (Ed.). (2014). *The Oxford Handbook of Clinical Psychology.* UK: Oxford University Press.

Bisson, J.I., & Cohen., J.A. (2006). Disseminating early interventions following trauma. *Journal of Traumatic Stress*, *19*(5), 583-595.

Bjelland, I., Dahl, A.A., Haug, T.T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated literature view. *Journal of Psychosomatic Research, 52*(2), 69-77.

Blanchard, E.B., Hickling, E.J., Freidenberg, B.M., Malt, L.S., Kuhn, E., & Sykes, M.A. (2004). Two studies of psychiatric morbidity after motor vehicle accident survivors 1 year after the crash. *Behaviour Research and Therapy, 42,* 569-583.

Blake, D.D., Weathers, F., Nagy, L.M., Kaloupek, D.G., Gusman, F.D., Charney, D.S., & Keane, T.M. (1995). The development of a clinician administered PTSD scale. *Journal of Traumatic Stress, 8*(1), 75-90.

Bonanno, G.A. (2004). Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist, 59*(1), 20-28.

Bonanno, G.A. (2005). Resilience in the face of potential trauma. *Current Directions in Psychological Science, 14*(3), 135-138.

Bonanno, G.A., & Field, N.P. (2001). Examining the delayed grief hypothesis across 5 years of bereavement. *American Behavioral Scientist, 44*(5), 798-816.

Bonanno, G.A., Galea, S., Bucciarelli, A., & Vlahov, D. (2007). What predicts psychological resilience after disaster? The role of demographics, resources, and life stress. *Journal of Consulting and Clinical Psychology, 75*(5), 671-682.

Bonanno, G.A., Kennedy, P., Galatzer-Levy, I.R., Lude, P., & Elfstrom, M.L. (2012). Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabilitation Psychology, 57*(93), 236-247.

Bonanno, G.A., & Mancini, A.D. (2012). Beyond resilience and PTSD: Mapping the heterogeneity of response to potential trauma. *Psychological Trauma: Theory, Research, Practice & Policy, 4*(1), 74-83.

Bonanno, G.A., Moskowitz, J.T., Papa, A., & Folkman, S. (2005). Resilience to loss in bereaved spouses, bereaved parents, and bereaved gay men. *Journal of Personality and Social Psychology, 88*(5), 827-843.

Brennan, C., Worrall-Davis, A., McMillan, D., Gilbody, S., & House, A. (2010). The Hospital Anxiety and Depression Scale: a diagnostic meta-analysis of case-finding ability. *Journal of Psychosomatic Research, 69,* 371-378.

Bryant, R.A. (2011). Mental disorders and traumatic injury. *Depression and Anxiety, 28,* 99-102.

Bryant, R.A., Harvey, A.G., Guthrie, R.M., & Moulds, M.L. (2000). A prospective study of psychophysiological arousal, acute stress disorder, and posttraumatic stress disorder. *Journal of Abnormal Psychology, 109*(2), 341-344.

Bryant, R.A., Moulds, M.L., & Nixon. (2003). Cognitive behaviour therapy of acute stress disorder: A four year follow-up. *Behaviour Research and Therapy, 41*(4), 489-494.

Bryant, R.A., O'Donnell, M.L., Creamer, M.C., McFarlane, A.C., Clark, C.R., & Silove, D. (2010). The psychiatric sequelae of traumatic injury. *American Journal of Psychiatry, 167,* 312-320.

Buckley, T.C., Blanchard, E.B., & Hickling, E.J. (1996). A prospective examination of delayed onset PTSD secondary to motor vehicle accidents. *Journal of Abnormal Psychology, 105*(4), 617-625.

Cosco, T.D., Doyle, F., Ward, M., & McGee, H. (2012). Latent structure of the Hospital Anxiety and Depression Scale: a 10-year systematic review. *Journal of Psychosomatic Research, 72*(3), 180-184.

Cox, B.J., Clara, I.P., & Enns, M.W. (2002). Posttraumatic stress disorder and the structure of common mental disorders. *Depression and Anxiety, 15,* 168-171.

Coyne, J.C., & van Sonderen, E. (2012). No further research needed: abandoning the Hospital and Anxiety Depression Scale (HADS). *Journal of Psychosomatic Research, 72*(3), 173-174.

Creamer, M., Burgess, P., McFarlane, A.C. (2001). Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychological Medicine, 31,* 1237-1247.

Davydow, D.S., Zatzick, D.F., Ruvara, F.P., Jurkovich, G.J., Wang, J., Roy-Byrne, P.P.,… Mackenzie, E.J. (2009). Predictors of posttraumatic stress disorder and return to usual major activity in traumatically injured intensive care unit survivors. *General Hospital Psychiatry, 31,* 428-435.

deRoon-Cassini, T.A., Mancini, A.D., Rusch, M.D., & Bonanno, G.A. (2010). Psychopathology and resilience following traumatic injury: A latent growth mixture model analysis. *Rehabilitation Psychology, 55*(1), 1-11.

Deshields, T., Tibbs, T., Fan, M.Y., & Taylor, M. (2006). Differences in patterns of depression after treatment for breast cancer. *Psychooncology, 15,* 398-406.

Dunmore, E., Clark, D.M., & Ehlers, A. (2001). A prospective investigation of the role of cognitive factors in persistent Posttraumatic Stress Disorder (PTSD) after physical and sexual assault. *Behaviour Research and Theory, 38,* 319-345.

Ehlers, A., & Clark, D. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38,* 319-345.

Ehlers, A., Clark, D.M., Hackmann, A., McManus, F., Fennell, M., & Herbert, C. (2003). A randomised controlled trial of cognitive therapy, a self-help booklet, and repeated

assessments as early interventions for posttraumatic stress disorder. *Archives of General Psychiatry, 60*(10), 1024-1-32.

Galea, S., Ahern, J., Resnick, H., Kilpatrick, D., Bucuvalas, M., Gold, J., & Vlahov, D. (2002). Psychological sequelae of the September 11 terrorist attacks in New York City. *The New England Journal of Medicine, 346*(13), 982-987.

Grant, D.M., Beck, J.G., Marques, L., Palyo, S.A., & Clapp, J.D. (2008). The structure of distress following trauma: posttraumatic stress disorder, major depressive disorder, and generalised anxiety disorder. *Journal of Abnormal Psychology, 17*(3), 662-672.

Hobfoll, S.E., Palmieri, P.A., Johnson, R.J., Canetti-Nisim, D., Hall, B.J., & Galea, S. (2009). Trajectories of resilience, resistance, and distress during ongoing terrorism: The case of Jews and Arabs in Israel. *Journal of Consulting and Clinical Psychology, 77*(1) 138-148.

Hofmann, S.G., Vonk, I.J.J., Fang, A., Asnaani, A., & Sawyer, A.T. (2012). The Efficacy of Cognitive Behavioral Therapy: A Review of Meta-analyses. *Cognitive Therapy Research, 36*, 427-440.

Holbrook, T.L., Hoyt, D.B., Stein, M.B., & Sieber, W.J. (2001). Perceived threat to life predicts posttraumatic stress disorder after major trauma: Risk factors and functional outcome. *The Journal of Trauma: Injury, Infection, and Critical Care, 51*, 287-293.

Jung, T., & Wickrama, K.A.S. (2008). An Introduction to Latent Class Growth Analysis and Growth Mixture Modelling. *Social and Personality Psychology Compass, 2*(1), 302-317.

Koss, M.P., & Figueredo, A.J. (2004). Change in cognitive mediators of rape's impact on psychosocial health across 2 years of recovery. *Journal of Consulting and Clinical Psychology*, 72(6), 1063-1072.

Mancini, A.D., & Bonanno, G.A. (2006). Resilience in the face of potential trauma: Clinical practices and illustrations. *Journal of Clinical Psychology: In Session, 62*(8), 971-985.

Mason, S., Wardrope, J., Turpin, G., & Rowlands, A. (2002). The psychological burden of injury: an 18 month prospective cohort study. *Emergency Medicine, 19*, 400-404.

Mayou, R., Bryant, B., Ehlers, A. (2001). Prediction of psychological outcomes one year after a motor vehicle accident. *American Journal of Psychiatry, 158*, 1231-1238.

O'Donnell, M.L., Bryant, R.A., Creamer, M., & Carty, J. (2008). Mental Health following traumatic injury: Toward a health system model of early psychological intervention. *Clinical Psychology Review, 28*(3), 387-406.

O'Donnell, M.L., Creamer, M., Bryant, R.A., Schnyder, U., & Shalev, A. (2003). Posttraumatic disorders following injury: an empirical and methodological review. *Clinical Psychology Review, 23*, 587-603.

O'Donnell M.L., Creamer, M.C., McFarlane, A.C., Silove, D., & Bryant, R.A. (2010). Does access to compensation have an impact on recovery outcomes after injury? *Medical Journal of Australia, 192*(6), 328-333.

O'Donnell, M.L., Creamer, M., Pattison, P. (2004). Posttraumatic stress disorder and depression following trauma: Understanding comorbidity. *American Journal of Psychiatry, 161*, 1390-1396.

O'Donnell. M.L., Lau, W., Tipping, S., Holmes, A.C.N., Ellen, S., Judson, R.,…Forbes, D. (2012). Stepped early psychological intervention for posttraumatic stress disorder, other anxiety disorders, and depression following serious injury. *Journal of Traumatic Stress, 25*(2), 125-133.

Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). Predictors of post-traumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129,* 52-73.

Quale, A.J., & Schanke, A. (2010). Resilience in the face of coping with a severe physical injury: A study of trajectories of adjustment in a rehabilitation setting. *Rehabilitation Psychology, 55*(1), 12-22.

Quale, A.J., Schanke, A., Froslie, A.F., & Roise, O. (2009). Severity of injury does not have any impact on posttraumatic stress symptoms in severely injured patients. *Injury, 40,* 498-505.

Richmond, T.S., & Kauder, D. (2000). Predictors of psychological distress following serious injury. *Journal of Traumatic Stress, 13*(4), 681-691.

Richmond, T.S., Ruzek, J., Ackerson, T., Wiebe, D.J., Winston, F., & Kassam-Adams, N. (2011). Predicting the future development of depression or PTSD after injury. *General Hospital Psychiatry, 33*, 327-335.

Schafer, J., & Graham, J. (2002). Missing data: our view of the state of the art. *Psychological Methods, 7,* 147-177.Schnyder, U., Moergeli H., Klaghofer, R., & Buddeberg, C. (2001). Incidence and prediction of posttraumatic stress disorder symptoms in severely injured accident victims. *American Journal of Psychiatry, 158,* 594-599.

Sheehan, D.V., Lecrubier, Y., Harnett-Sheehan, K. Et al. (1998). The Mini International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview. *Journal of Clinical Psychiatry, 59* (suppl 20), 22-23.

Singer, J. (1998). Using SAS Proc Mixed to fit multilevel models, hierarchical models and individual growth models. *Journal of Educational and Behavioural Statistics*, *24*, 323-355.

Sorberg, H.L., Bautz-Holter, E., Roise, O., & Finset, A. (2010). Mental health and posttraumatic stress symptoms 2 years after severe multiple trauma: self-reported disability and psychosocial functioning. *Archives of Physical and Medical Rehabilitation, 91,* 481-488.

Starr, A.J., Smith, W.R., Borer, D.S., Morgan, S.J., Reinert, C.M., Mendoza-Welch, M. (2004). Symptoms of posttraumatic stress disorder after orthopaedic trauma. *The Journal of Bone and Joint Surgery, 86*(6), 1115-1121.

Steel, J.L., Dunlavy, A.C., Stillman, J., & Paper, H.C. (2011). Measuring depression and PTSD after trauma: common scales and checklists. *Injury, 42*(3), 288-300.

Weathers, F.W., Keane, T.M., & Davidson, J. (2001). Clinician-administered PTSD scale: A review of the first ten years of research. *Depression and Anxiety, 13*(3), 132-156.

White, B., Driver, S., & Warren, A.M. (2008). Considering resilience in the rehabilitation of people with traumatic disabilities. *Rehabilitation Psychology, 53*(1), 90-17.

Wiseman, T., Foster, K., & Curtis, K. (2013). Mental health following traumatic physical injury: An integrative literature review. *Injury, 44,* 1393-1390.

Zatzick, D.F., Jurkovich, G.J., Gentilello, L., Wisner, D., & Rivara, F.P. (2002). Posttraumatic stress, problem drinking and functional outcomes after injury. *Archives of Surgery, 137*, 200-205.

Zigmond, A., & Snaith, R. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavia, 67,* 361-370.

Chapter Three. The Role of Site and Severity of Injury as Predictors of Mental Health Outcomes following Traumatic Injury

3.1 Abstract

***Objective*:** Prevalence studies have consistently highlighted an association between traumatic physical injury and reduced mental health. Currently however, there is a paucity of research which has examined the role that injury-related characteristics play in the development of depression, anxiety and PTSD symptomatology following injury. Accordingly, the aim of this study was to investigate the influence of injury site and severity as predictors of mental health outcomes across the initial 12-months following traumatic injury.

***Methods*:** Using a multi-site, prospective longitudinal study, participants with a traumatic physical injury (N=1098) were assessed during hospital admission, and followed up at 3 months (N=932, 86%) and at 12 months (N=715, 71%). Injury site was measured using the Abbreviated Injury Scale 90 (AIS); and objective injury severity was measured using the Injury Severity Score (ISS). Participants completed the Hospital Anxiety and Depression Scale (HADS) and the Clinician Administered PTSD Scale (CAPS). A random intercept mixed modelling analysis was conducted to evaluate the effects of site and severity of injury in relation to anxiety, PTSD and depressive symptom severity.

***Results*:** Injury severity was only positively correlated with PTSD symptoms. Head, face and external injury were also positively associated with PTSD symptom severity. In contrast, lower extremity injury and external injury were associated with depression symptom severity. The findings also revealed that the presence of any injury, irrespective of site or severity, was associated with elevated levels of depression, anxiety and PTSD symptom severity.

***Conclusions*:** The findings suggest that the presence of physical injury is more important than the objective severity of injury per se, as a predictor of reduced mental health following traumatic injury. Further, whilst there was no uniform relationship between individual sites and each of depression, anxiety and PTSD symptomatology, a mixed pattern of findings emerged such that some sites (in particular head, face, lower extremity and external injury) exhibited a relationship with a specific mental health outcome.

3.2 The Role of Site and Severity of Injury as Predictors of Mental Health Outcomes following Traumatic Injury

Traumatic injury, defined within the literature as physical injury severe enough to require hospitalisation (O'Donnell, Bryant, Creamer, & Carty, 2008; Quale & Schanke, 2010), has been found to be one of the leading precipitants of trauma-related psychiatric disorders (O'Donnell et al., 2008). Prevalence rates of psychological morbidity (including posttraumatic stress disorder [PTSD], anxiety and depression) following traumatic injury have ranged from 17.5% to 42% at 6 months, and 2% to 36% at 12 months (O'Donnell, Creamer, Bryant, Schnyder, & Shalev, 2003). Given the global burden of traumatic injury, it represents a pertinent public health issue (Creamer, Burgess, & McFarlane, 2001), suggesting that an understanding of, and a subsequent need for action, will be required to reduce its financial, physical, psychological and infrastructural impact.

Risk factors for decreased mental health following exposure to traumatic physical injury include pre-injury, peri-injury and post-injury features of both the individual and the environment (Doron-LaMarca, Vogt, Saxe, King, & King, 2010). Of the pre-injury factors, positive associations have consistently been found between particular demographic characteristics and reduced mental health; including younger age, female gender, history of psychiatric disorder prior to the injury and history of exposure to previous traumatic events (Creamer et al., 2001; Doron-LaMarca et al., 2010; Quale, Schanke, Froslie, & Roise, 2009; Steel, Dunlavy, Stillman, & Paper 2011).

Whilst the body of work investigating these demographic predictors is substantial, there is a paucity of research evaluating the association between injury-

specific characteristics, such as injury site and severity, and mental health outcomes including PTSD, anxiety and depression. As a result, the impact of both the site of injury and its severity on mental health outcomes remains unclear.

Conceptual frameworks of mental health following traumatic injury

Identifying a conceptual framework that explains the associations of site and severity of injury with mental health outcomes will be valuable in improving our understanding of the impact of traumatic injury on psychopathology. A conceptual framework would allow the development of more accurate screening tools for early intervention. In addition, it would guide and expedite the most appropriate treatment options, ultimately assisting in the reduction of the financial burden of injury. There are two seemingly contradictory conceptual approaches that may be related to psychopathology following injury, the first being the conservation of resources (COR) theory (Hobfall, 1989) and the second, more recent, transdiagnostic models. To date, injury site and severity have not been examined under the auspices of either of these competing approaches. Additionally, a reflection of cognitive models of trauma etiology may also be of relevance to this study.

The transdiagnostic approach uses the overlap between symptomatology and etiological pathways, neuroscientific studies of amygdala feedback, and common latent structures between PTSD, generalised anxiety disorder (GAD) and major depressive disorder (MDD), to suggest that all three disorders load onto one higher order non-specific construct, or a ‘dysphoria factor’ (Cox, Clara, & Enns, 2002; Grant, Beck, Marques, Palyo, & Clapp, 2008; Simms, Watson, & Doebbeling, 2002; Slade & Watson, 2006; Yufik & Simms, 2010). Despite the fact that much of the traumatic injury literature operationalises mental health outcomes through measures of general

distress that include a range of anxiety, depressive, traumatic stress, psychosocial and wellbeing indicators, traumatic injury has not been directly investigated under this approach. Given the consistent link between traumatic injury and both broad and specific mental health outcomes (PTSD: Davydow et al., 2009; O'Donnell, Creamer, Bryant, Schnyder, & Shalev, 2003; Starr et al., 2004; anxiety: Bryant et al., 2010; depression: Bryant, 2011; Richmond et al., 2010; 'distress' or 'function outcome': Holtslag, Post, Lindeman, & van der Werken, 2007; Read et al., 2004; Vles et al., 2005), this pattern of findings may be indicative of the transdiagnostic framework, a lens of study through which this context has yet to be investigated.

Alternatively, an integrated resource model such as the COR theory (Hobfoll, 1989; Hobfoll, 2002) might explain traumatic injury trends. This model purports that people strive to obtain, retain and protect resources, and that stress occurs when these resources are lost, threatened, or when individuals fail to consolidate further resources after substantial investment. Conservation of resources theory has received support along the full severity of the traumatic stress spectrum, from events such as workplace burnout (Grandey & Cropanzano, 1999), to war and disaster (Ironson, et al., 1997; King, King, Foy, Keane, & Fairbank, 1999). Within the realms of Hobfoll's (1989) primary definition and for the purposes of the current study, 'resources' can be operationalised as a person's pre-injury physical functioning capability; and 'stress' can be operationalised as reduced mental health outcome. In this way, reduced mental health as a result of traumatic injury would be reflective of the loss and/or potential loss of physical integrity, functionality, and self-identity. This perspective may shed light on the impact of the severity of injury on mental health outcome, suggesting that, if greater severity of injury were to lead to greater resource loss, mental health

outcomes would subsequently decline in a linear trajectory. Furthermore, notwithstanding the severity of injury, this model might also explain why the presence of injury leads to a decrease in mental health outcome (as suggested by Delahanty, Raimonde, Spoonster, & Cullado, 2003; Gabert-Quillen, Fallon, & Delahanty, 2011; Koren, Norman, Cohen, Berman, & Klein, 2005). That is, the simple presence of any injury, irrespective of its severity, represents a loss of resources which in turn, regardless of the extent of that resource loss, negatively impacts mental health.

A discrete exploration of both site and severity of injury on individual mental health outcomes may identify which of these two conceptual approaches aligns best with the traumatic injury literature; and in this way enhance our ability to identify risk or vulnerability factors for reduced mental health following injury.

It is also possible that a cognitive theory of posttraumatic sequelae might be relevant for both site and severity of injury. Ehlers and Clark (2000) posit that the appraisal of the activating event and an individual's initial emotional response will subsequently influence the development and maintenance of PTSD. In this way, studies have connected PTSD with interpersonal violence as a predictor of poor outcome, suggesting that the beliefs that individuals have about and after the trauma (inclusive of their capacity to cope or likelihood of recovery) will influence adjustment (Briere 2006; Weaver, Griffin, and Mitchell, 2014b). That is, a person who appraises the event as, for example, being out of their control or as representing the danger in the world and a perceived helplessness to influence it, is likely to experience poorer psychological adjustment to the experience which in turn will delay their psychological recovery.

At the same time, studies exploring body perceptions after injury (Weaver et al., 2004a and b) have associated elevated body image distress with depression and PTSD. Body image distress is conceptualised as an individual's subjective sense of their body based largely upon appearance as some well behavioural, perceptual, cognitive and affective phenomena (Weaver et al., 2014b). This concords with research by Fukinishi (1999) and Madianos et al., (2001) on the disfigurement, in which the authors posit disfigurement as a causal mechanism of PTSD following injury. Given that disfigurement and body image distress have been conceptualised as subjective perceptions (Weaver et al., 2014b), this assertion concurs with cognitive theories that place the individual's negative interpretation of the injury as the prime influencer of reduced mental health. In this way, it might be expected that body sites which are more visible to the general public, to be linked with poor adjustment, in particular depression and PTSD (Weaver et al., 2014a and b) due to the individual's negative body image of the injury in that particular site.

Injury site as a predictor of mental health

Research has produced mixed results when investigating the impact of injury (body) site as a predictor of mental health outcome following traumatic injury. The few studies including injury site as a predictor of mental health outcomes have generally focused on a single injury site. That is, they have compared outcomes within single injury sites and/or single outcomes (such as facial injury as a predictor of depression; or spinal cord injury as a precursor to PTSD) rather than comparing different mental health outcomes between injury sites (Fukunishi, 1999; Holtslag et al., 2007a; Holtslag, van Beeck, Lindeman, & Leenan, 2007). A prospective cohort study by Haagsama et al. (2012) found head and extremity injury to be significantly associated with high

posttraumatic stress symptomatology (reaching diagnostic caseness of PTSD) two years after injury, compared to other body sites which did not show the same association. Upper extremity and spinal cord injury were found to be associated with poorer functional health (where 'functional health' is defined by Holtslag et al. 2007a, p. 281 as "limitations in the performance of everyday activities due to health problems") and subsequently lower quality of life (Holtslag et al., 2007a; Holtslag et al., 2007b; Mackenzie, Shapiro, & Smith, 1987; Mackenzie, Siegel, & Shapiro, 1988). Other studies have identified that it is the extent of disfigurement to the face, head and neck (e.g. as a result of burn injury) that is positively correlated with PTSD severity, rather than the impact of the site of injury itself (Fukunishi, 1999; Glynn, Shetty, & Dent, 2010; Madianos, Papaghelis, Ioannovich, & Dafni, 2001). For example, Fukunishi (1999) evaluated the relationship between PTSD and depression with facial burn injury and/or digital amputation. The researchers measured the two discrete mental health outcomes with each of the injury sites, providing an understanding of the prevalence of specific outcomes for the targeted injuries and found that it is the extent of cosmetic disfigurement that impacts depression and PTSD, rather than the location of the injury itself. However, they left unaddressed questions regarding the impact of other injury sites with additional mental health outcomes, such as anxiety. As a result, in spite of this study, the relative and comparative effects of specific injury sites in relation to depression, anxiety and PTSD remains unclear.

In a major prospective cohort study evaluating the influence of personal and injury characteristics on functional health, Holtstag et al. (2007a) also only examined a single (rather than comparative) mental health outcome. The researchers compared a variety of body sites including chest, spinal cord, lower extremity and upper extremity;

however the primary outcome measure was an overall 'functional health status'. As a consequence, the authors did not specifically assess the impact of injury site on anxiety and depressive symptomatology individually, nor allow for a comparison between the two mental health outcomes. In their second study using the same sample (Holtstag et al., 2007b), further methodological limitations included the use of self-report subscales of anxiety and/or depressive symptoms within a measure of overall quality of life, which were then subsumed into one overall dimension in the statistical analyses. Once again, the specificity of anxiety and depressive symptoms could not be delineated.

A more recent prospective cohort study examined 'probable' PTSD in 226 major trauma patients at 1 and 2 years post-injury (Haagsama et al., 2012). Results revealed that head and extremity injury were associated with probable PTSD (where 'probable PTSD' was measured by symptomatology from the Impact of Events Scale [IES; Horowitz, Wilmner, & Alvarez, 1979], which assessed 2 of 3 PTSD symptom clusters according to the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000; DSM-IV-TR). However, a restricted sample of 'high severity level' injuries (as measured by a 16 or higher on the Injury Severity Score [ISS; Baker, O'Neil, Haddon, & Long, 1976]) may have led to a cohort effect, resulting in reduced generalisability of findings to a broader population of individuals with injuries of varying severities. Furthermore, notably absent in this study (akin to other studies (e.g., Fukunishi, 1999)) were comparative mental health outcome measures of anxiety and depression.

Objective injury severity as a predictor of mental health

Studies examining the differences in PTSD symptoms between individuals exposed to trauma, both with and without injury, have consistently found that the

presence of injury (rather than the severity or extent of injury), predicts mental health outcomes (Delahanty et al., 2003; Gabert-Quillen et al., 2011; Koren et al., 2005). Much of this research has been conducted using between-group comparisons (individuals who have vs. have not been injured) rather than utilising within-group methodology (comparing the outcomes of individuals from a population comprised only of people who have experienced traumatic injuries). This leaves unanswered questions as to the differences that might occur within this specific population.

Studies that have examined the extent to which the objective severity of injury predicts PTSD and other psychiatric disorders have produced equivocal results. Several studies have reported no relationship between the objective severity of injury (as measured by the ISS) and mental health outcomes such as depression, anxiety, PTSD including PTSD symptoms, quality of life, and functional health status (Andrews, Brewin, Rose, & Kirk, 2000; Koren, Arnon, &, Klein, 1999; Mason, Turpin, Woods, Wardrope, & Rowlands, 2006; Quale & Schanke, 2010; Schnyder, Moergeli, Klaghofer, & Buddeberg, 2001). In contrast, at least one study reported a negative relationship, whereby higher ISS predicted lower PTSD (Delahanty et al., 2003). Other studies have observed a strong positive correlation between injury severity and higher levels of psychopathology symptoms inclusive of posttraumatic stress, depressive and general distress indicators (Frommberger et al., 1998; Jeavons, 2000).

Limitations within the current literature

Differences in the observed relationships between injury severity and mental health may be partly attributed to differences in the measures used to assess injury, including the ISS, the Abbreviated Injury Scale 90 (AIS; Baker et al., 1974), and the New Injury Severity Score (NISS; Osler, Baker, & Long, 1997). Likewise, uncertainty

regarding the impact of injury sites on specific mental health outcomes appears to be compounded by the use of a variety of outcome measures between studies, including quality of life, functional distress, and symptom versus diagnostic caseness (Holtslag et al., 2007a). Studies of both site and severity have also varied in the presence of moderators such as pain or peri-traumatic dissociation, which have been shown to correlate with poorer mental health outcomes (Fulsang, 2000; O'Donnell et al., 2003). Variability in findings is also likely to be affected by sample selection and restriction. For example, samples made up of populations of soldiers versus motor vehicle accident (MVA) victims (Delahanty et al., 2003; Grieger et al., 2006; Koren et al., 2005), or studies that examine only 'severely' injured patients rather than including participants with a range of injury severities (Schnyder et al., 2001). Such limitations could be mitigated by the use of a more heterogeneous sample of survivors suffering a broad range of traumatic physical injuries, in turn facilitating a comparison of the effects of multiple body sites and severities on a range of mental health outcomes (notably depression, anxiety and PTSD).

Summary

Although some aspects of traumatic injury, including prevalence and demographic predictors of depression, anxiety and PTSD (such as age and gender) have been well-documented (Doron-LaMarca et al., 2010; Quale et al., 2009; Steel et al., 2011; Wiseman, Foster, & Curtis, 2013); methodological limitations have led to inconsistent findings regarding the impact of injury characteristics, specifically site and severity of injury in relation to depression, anxiety and PTSD symptom severity outcomes. There have also been very few published studies to date that have explored all three mental health outcomes within the same injured population. Despite recent

transdiagnostic approaches to psychological sequelae (O'Donnell et al., 2004), the lack of within-study comparative mental health outcome studies limits our understanding of both individual symptom profiles as well as any potential overlap between the three mental health outcomes. Thus, whilst the evidence to date is able to confirm that people who experience a traumatic injury also report mental health symptoms (Wiseman et al., 2013) and indeed have been shown to have poorer mental health than those without traumatic injury (Cameron et al., 2006), it would be beneficial to evaluate the impact of site and severity of injury in relation to depression, anxiety and PTSD symptom severity, as well as explore the patterns of these three mental health outcomes over time. An understanding of these delineated patterns based upon specific injury characteristics may lead to identification of a need for differences in screening, early intervention and/or subsequent treatments for the differentiated mental health outcomes, and in this way, improve the accuracy and specificity of rehabilitation management.

Aims of Present Study

The primary aim of this study was to investigate whether site and severity of injury are predictive of depression, anxiety and PTSD symptom severity over a 12 month period following a traumatic injury. On the basis of the mixed findings within the literature, three hypotheses were tested. First, acknowledging the mixed results from previous studies which tend to indicate a lack of support for the association between injury severity and poor mental health outcomes (Gabert-Quillen et al., 2011), the influence of the cognitive models of the development of PTSD (Ehlers and Clark, 2000; Foa and Rothbaum, 1989) suggests that if the objective severity of an injury is misinterpreted or appraised negatively, a poorer outcome will ensue. Thus, it was

hypothesised that objective severity of injury would associated with elevated PTSD symptom severity within the initial 12-months post-injury. Further, based upon the lack of studies and theoretical and empirical evidence, it was hypothesised that this association would not be extended to anxiety or depression.

Second, based upon the weight of the literature exploring injury sites and mental health outcomes and the suggested underlying causal mechanisms of disfigurement precipitated by body image distress (Weaver et al., 2014a, Weaver et al., 2014b., Ehlers and Clark 2001, Briere 2006), it was expected that the injury sites which are most visible, would be associated with elevated symptoms of depression and PTSD, although not anxiety. Specifically, it was hypothesised that facial, head, external, upper and lower extremity injury would be associated with elevated depression and PTSD.

Third, it was expected that the presence of an injury in any site would be related to elevated depression, anxiety and/or PTSD symptom severity in comparison to participants without an injury in that same injury site (but who reported injury in another site). Taking into account the second hypothesis which suggests that certain injury sites would have a greater psychological impact, it is still hypothesised that the presence of any injury itself would be associated with elevated symptoms of each mental health outcome, compared to an absence of that same injury (Delahanty et al., 2003; Gabert-Quillen et al., 2011).

3.3 Method

Participants

Participants were recruited from admissions from four level 1 trauma hospitals in three states of Australia (Westmead Hospital, New South Wales; Alfred and Royal Melbourne Hospitals in Victoria; and Queen Elizabeth Hospital in South Australia). A random sample of patients was recruited from weekday trauma admissions over 23 months (13 March 2004 – 21 February 2006). Inclusion criteria included proficiency in English, age between 16 and 70 years, and an injury serious enough to require hospitalisation of more than 24 hours. Patients with mild traumatic brain injury (TBI; as defined by the American Congress of Rehabilitation Medicine, 1993) were eligible to participate; however those with severe or moderate TBI were excluded. Patients were further excluded if they were suicidal or psychotic, were non-Australian visitors/tourists or had cognitive impairment. Throughout the 2 year period, 3771 patients met inclusion criteria and 1593 participants were randomly selected using an automated, random selection procedure, stratified by length of hospitalisation. Random selection was used in preference to a consecutive design as the numbers of patients admitted exceeded the allocated recruitment processes. Of these 1593 potential participants, 1166 (73%) consented to be involved in the study, with complete intake data being collected on 1062 participants (91%) and 715 participants (71%) completing the 12 month follow-up assessment.

The mean age of participants on admission was 37.8 years (*SD* = 13.7). The sample was comprised of 73.9% males (*n* = 811) and 26.1% females (*n* = 287). The mean number of injuries per person was 3.8 (*SD* = 2.54); and the mean Injury Severity Score was 11.17 (*SD* = 8.01), which is in the moderate range of severity.

Analysis of the data set from the larger study (from which this study was derived) revealed that individuals who refused to participate did not differ from those

who participated in terms of gender, length of hospital admission, injury severity or age. Patients who did not complete the 12 month follow-up assessment did not differ from those who did in regards to gender, length of hospitalisation or injury severity. However, non-completers were younger (M = 35.1 years, SD = 12.9 vs. M = 39.7 years, SD = 13.7, $t(1162) = -5.7$, $p<.001$).

Measures

Injury site. Injury site was measured using the Abbreviated Injury Scale 90 (AIS; Baker et al., 1974) and taken from each patient's hospital records. The AIS is an anatomically-based classification system that categorises individual injuries by body region and severity, where body regions (injury sites) are classified as: head, face, neck, thorax, abdomen, spine, upper extremity, lower extremity and external (skin); and severity is rated on a 6 point ordinal scale ranging from AIS 1 (minor) to AIS 6 (untreatable). Given that individuals with spinal cord injuries were not admitted to the four study hospitals, the spinal categorisation in the current study excluded spinal cord injuries.

Injury severity. Injury severity was measured in two ways. Firstly, it was assessed as a global measure using the ISS (Baker et al., 1976). The ISS is derived from the sum of the squares of the highest AIS scores in three different body regions. It was developed to provide a coding system with a better fit between overall severity and survival and allows for multiply-injured people (whereas the AIS does not). In subsequent analyses, injury severity was also assessed as a localised measure derived from the AIS severity rating. This second measure evaluated severity as the maximum

AIS severity per person; that is, the rating of the most severe injury out of each participants' injuries, irrespective of the injury site.

Psychiatric History. The Mini International Neuropsychiatric Interview version 5.5 (MINI; Sheehan, Lecrubier, & Harnett-Sheehan, 1998) was used to measure lifetime history of major depression, dysthymia, panic disorder, social phobia, obsessive-compulsive disorder, PTSD, GAD, alcohol abuse and alcohol dependence. The MINI is a brief, structured diagnostic interview based on the DSM-IV and International Statistical Classification of Diseases and Related Health Problems – 10th Revision (ICD-10); and has sound reliability for each diagnosis (Sheehan et al., 1998). For the current study, the MINI variable was dichotomised such that the presence/absence of any psychiatric history was observed and incorporated as a predictor variable.

Posttraumatic stress symptoms (PTSD symptoms). The Clinician Administered PTSD Scale (CAPS; Blake et al., 1995) was administered in the acute setting (1 week post-injury) and at 3 and 12 months post-injury. The CAPS is one of the most widely used tools for the diagnosis of PTSD and has been found to have excellent reliability and validity (Weathers, Keane, & Davidson, 2001). Posttraumatic stress symptoms in the acute setting were assessed excluding the 1 month time criterion; rather, a 'since you were injured' time criterion was incorporated. Telephone assessments (conducted at 3 months and 12 months post-injury) were recorded digitally to ensure consistency with the protocol. Inter-rater reliability was tested by having 5% of all CAPS interviews tested by an independent assessor (blind to the original scoring) who reviewed recordings of the original diagnostic interview. The diagnostic consistency on the CAPS was found between assessors to be 0.97 at baseline, 1.00 at 3

months and 0.99 at 12 months post-injury. In the current study, CAPS was used as a continuous variable to measure PTSD symptom severity, rather than as a dichotomous variable of PTSD.

Anxiety and Depressive Symptoms. The presence and severity of depressive and anxiety symptoms was measured using the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), which is a self-report questionnaire that is suitable for injury populations as it does not measure somatic symptoms. The HADS has excellent discriminant validity and internal consistency as well as good factor structure (Bjelland, Dahl, Haug, & Neckelmann, 2002). Rather than using the HADS scores as a diagnostic tool or dichotomous variable in the current study, the continuous variables were used to assess symptom severity.

Procedure

Ethics was approved by the human research ethics committee at each hospital and at the University of Melbourne for the larger scale trial. It was subsequently approved by Macquarie University Human Ethics committee based upon use of the relevant measures for the current study.

Following written consent, baseline assessments were conducted on average 7 (*SD* = 7.8) days after the initial assessment for injury for all eligible participants. The assessment comprised a structured clinical interview in which the CAPS and MINI were administered to assess the presence of posttraumatic stress symptomatology; and further self-report questionnaires that also included the HADS. Interviews were conducted just prior to discharge when IV narcotic opiods had ceased. Some people were discharged on oral opiods and other pain medication. Characteristics of injuries

were obtained from automated hospital-based registry systems and included ISS, length of hospitalisation, Intensive Care Unit (ICU) admission and discharge destination. Participants were subsequently assessed at 3 months and 12 months post-admission, using the CAPS to assess posttraumatic stress symptoms via telephone. They were also sent self-report questionnaires containing the HADS, which were returned in a reply-paid envelope.

Statistical Analyses

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) Version 16. Means, standard deviations and frequencies were calculated to identify the characteristics of the sample and examine the prevalence of anxiety, depression and posttraumatic symptom severity and psychological history. There were n = 54 who did not have an identified injury. These scores were attributed to missing data and therefore disregarded in the analysis.

The main analyses were based on a linear mixed model, or multi-level model (Singer, 1998); in particular, a random intercept model. This method provided an alternative analysis to univariate or multivariate analyses of repeated measures that could be fitted with maximum likelihood methods, taking into account missing data in longitudinal/multi-phase datasets. This pattern of missing data is a commonly recognised challenge in the use of longitudinal datasets (Commenges & Dartigues, 1997; Gerstof, Herlitz, & Smith, 2006; Jacqmin-Gadda, Fabrigoule, Schafer & Graham, 2002; Singer, 1998). Linear mixed models allow for individual differences in growth curves to be examined. This analysis was deemed an appropriate choice as the current study was based on a longitudinal dataset, was not experimental and evaluated more than two outcomes.

Missing data

There are two common approaches which allow valid statistical inference in the occurrence of missing data. The first is multiple imputation (Sinharay, Stern, & Russell, 2001); the alternative is the maximum-likelihood estimation using the incomplete data (Schafer & Graham, 2002). Each of the two methods is contingent on the assumption that the data are missing at random (MAR); that is, missingness is random and independent of the data which has been collected. Plausible violations of the assumption would occur, for example, if a change in circumstances inhibited an individual's availability to complete the questionnaires at any of the time points. It is proposed here that this kind of change, though possible, would be a relatively unique reason for not taking part in the follow-up assessment, when compared with so many other possible reasons. Thus, in line with Schafer and Graham's (2002, p. 173) position that "failure to account for the cause [of missingness] seems capable of introducing only minor bias" and therefore meeting the assumption that data are missing at random, valid inferences could be made from our data using the maximum-likelihood method. In contrast, multiple imputation is most useful when the available sample of observations is small enough for the imputed data to significantly increase the power of the analysis. Given the current sample size and number of variables evaluated, the multiple imputation method appeared to be less suitable for analysing the current data.

Composition of model

Random intercept linear mixed modelling was used to evaluate the effects of site and severity of injury and on the trajectory of psychopathology over time. The participant variable was treated as a random factor. This meant that the between-subject variability of the multiple observations for each participant was represented by

random variation of their mean (or, intercept scores) around a fixed intercept. Thus, the correlation amongst the values of the dependent variable (specifically depression, anxiety and PTS scores) that came from the same person could be assessed and incorporated into the analysis. The other random term reflected the variation of each subject's score on a particular measure at a given time around the mean of all their scores.

Specifically, the random intercept multi-level model included:

- *Level 1* – multiple observations of the dependent variables: depression, anxiety and PTSD symptom severity for each subject over time (Time 1 [T1] = baseline/admission; Time 2 [T2] = 3 months; Time 3 [T3] = 12 months)
- *Level 2* – age, gender, injury site, injury severity (both ISS and AIS variants) and presence of psychiatric history.

The fixed terms for the intercept used in this model include the injury site (1 = 'presence of injury in a given site', 0 = 'no injury in that site'), age (at baseline, centred around the mean), gender (0 = male, 1 = female), psychiatric history (0 = no history, 1 = any history) and the ISS (at baseline, centred around the mean), which had a range from 1 to 75. Time was treated as a categorical variable (T1, T2, T3), as any changes over time were expected to be non-linear. The selection of age, gender and psychiatric history as variables included in the model was based upon the consistent finding throughout the literature regarding their impact on mental health outcome after traumatic injury (O'Donnell et al., 2010; Ozer, Best, Lipsey, & Weiss, 2003). Two variants of severity specific to given injury locations were also employed based upon the AIS severity rating. The AIS severity rating was used to ascertain the maximum

AIS severity (scored 1 - 6) for each participant, and the sum of the AIS severity ratings for each participant.

Since the random effects included in the model represented individual variation around the intercept, the model could thus be classified as a random intercept model. A *p* value below .05 was considered to be statistically significant. Furthermore, effect sizes were calculated with a coefficient of determination analysis of variance (referred to as R2). This method was deemed most appropriate for the analysis because it applies equally to numeric and categorical variables and is suitable for models and variables.

Specific analyses

The primary terms of interest for this study include both the main effects of the variables (site, severity, age, gender, psychiatric history) on each mental health outcome (depression, anxiety, PTSD symptom severity); and the effects of the dependent variables on changes in the three mental health outcomes over time. In order to evaluate the aims for this study, random intercept linear mixed modelling was used to test, build and evaluate each step of the model. Thus, main effects, interaction effects and simple effect mixed modelling analyses of the appropriate dependent variables were conducted for each outcome measure, as appropriate to the particular hypothesis.

3.4 Results

Descriptive Data

Descriptive data for the sample are presented in Table 1. 1098 injury survivors met inclusion criteria (after excluding n = 14 missing cases) with an age range of participants from 16 to 71 years. The participants who met inclusion criteria reported injuries ranging from mild to profound (1 - 73), with the mean injury severity

categorised as moderate. The most common injury site was lower extremity (56.5%), followed by upper extremity (38.1%) and then head injury (28.4%).

Table 1

Characteristics of the Sample of Injury Patients

Variable	N	% of sample	*M*	*SD*
Gender				
Male	811	73.9	-	-
Female	287	26.1	-	-
Age				
Total sample	-	-	37.75	13.67
Female	-	-	39.13	14.29
Male	-	-	37.26	13.98
Psychiatric History				
MINI (y)	665	62.1	-	-
Injury Severity				
ISS	-	-	11.17	8.07
Injury Site				
Head (y)	312	28.4	-	-
Face (y)	202	18.4	-	-
Neck (y)	10	0.9	-	-
Thorax (y)	294	26.8	-	-
Abdomen (y)	149	13.6	-	-
Spine (y)	274	25.0	-	-
Upper extremity (y)	418	38.1	-	-
Lower extremity (y)	620	56.5	-	-
External Injury (y)	119	10.8	-	-

Note. MINI = Mini International Neuropsychiatric Interview; 'y' = presence of variable; % of participants with injuries in specific sites can be >100% due to multiple injuries.

Descriptive data – Injury site and frequency

Frequency analyses indicated that 20.2% (*n* = 225) of the full sample (*N* = 1098) reported having one injury; 21.3% reported experiencing two injuries (*n* = 237); and 18.7% reported experiencing 3 injuries (*n* = 205). The proportion of the sample who reported between 4 and 10 injuries comprised 37.9% (*n* = 416) of the sample.

Patterns of injury site characteristics are illustrated in Table 2 and Table 3. Table 2 presents the frequency by which participants reported multiple injuries in specific sites. Table 3 displays the object severity of injury (as measured by the ISS) for participants with and without injuries in particular sites. The mean ISS of the overall sample was 11.17 (*SD* 8.07).

Table 2

Frequency of Multiple Injuries per Injury Site (N=1098)

Site	Overall		1 injury/site		2 injuries/site		3 injuries/site		4+ injuries/site	
	N	%	*N*	%	*n*	%	*N*	%	*N*	%
Head	312	28.4	242	77.5	59	28.5	11	3.5	7	2.2
Face	202	18.4	120	59.4	43	21.2	25	12.4	16	7.9
Neck	10	0.90	9	90.0	-	-	1	10.0	-	-
Thorax	294	26.8	199	74.2	72	26.8	19	7.1	9	3.3
Abdomen	149	13.6	102	68.4	27	18.1	17	11.4	4	2.7
Spine	274	25.0	160	58.9	53	19.3	23	8.4	44	16.1
Upper	418	38.1	234	55.9	106	25.3	48	11.5	35	8.4
Lower	620	56.5	271	43.7	196	16.1	70	11.3	91	14.7
External	119	10.8	84	70.6	30	25.2	5	4.2	1	0.8

Note. % = percentage of participants who reported an injury in the site particular site.

Table 3

Injury Severity Characteristics of Participants by Site of Injury (N=1098)

Site	With Injury			Without Injury		
	N	*M*	*SD*	*N*	*M*	*SD*
Head	312	14.55	8.60	786	9.80	7.43
Face	202	13.06	8.71	896	10.74	7.86
Neck	10	7.10	4.18	1088	11.20	8.09
Thorax	294	18.16	9.98	804	8.57	5.25
Abdomen	149	18.52	11.78	949	10.02	6.63
Spine	274	14.14	9.07	824	10.16	7.45
Upper extremity	418	12.64	8.39	680	11.27	7.74
Lower extremity	620	11.97	8.36	478	10.13	7.57
External	119	11.94	7.99	979	11.07	8.08

Note. ISS = Injury Severity Score.

Preliminary Analyses

Sociodemographics. Main effect analyses (see Table 4) revealed a significant effect of gender and psychiatric history across each mental health outcome; whereas age reached significance for anxiety and posttraumatic stress symptomatology only. Specifically, females showed higher levels of anxiety (M = 2.32 vs. M = 2.03), depression (M = 1.99 vs. M = 1.84) (r^2=0.01, indicating a low clinical significance)

and posttraumatic stress (*M* = 4.36 vs. *M* = 3.43) (r^2=0.03, indicating a low clinical significance) symptomatology than males; participants with a psychiatric history exhibited higher levels of anxiety (*M* = 2.43 vs. *M* = 1.91) (r^2=0.05, indicating a low clinical significance), depression (*M* = 2.13 vs. *M* = 1.71) (r^2=0.03, indicating a low clinical significance) and posttraumatic stress (*M* = 4.42 vs. *M* = 3.37) (r^2=0.05, indicating a low clinical significance) symptomatology than those without a psychiatric history; and younger participants experienced significantly worse levels of anxiety (r^2=0.02, indicating a low clinical significance) and posttraumatic stress symptomatology (r^2=0.08, indicating a low-medium clinical significance) than older participants. There was no significant main effect of age on depression.

Table 4

Main Effects of Age, Gender, Psychiatric History on Anxiety, Depression and PTSD Symptom Severity

Variable	Gender			Psychiatric History			Age		
	F	*df*	*P*	*F*	*df*	*p*	*F*	*df*	*P*
Anxiety	22.21	997	.00**	83.09	996	.00**	3.89	1028	.05*
Depression	6.28	1002	.01*	58.63	1002	.00**	0.90	1032	.34
PTSD	49.89	1051	.00*	76.67	1047	.00**	13.98	1081	.00**

Note. Anxiety = HADS Anxiety score; Depression = HADS Depression score; PTSD = Clinician Administered PTSD Scale.

*p< .05

**p< .01

Interaction analyses were conducted to evaluate the interactions between the demographic factors of age, gender, psychiatric history and time. Results revealed a significant interaction between gender and the presence of psychiatric history for posttraumatic stress symptomatology, $F(1, 1079.45) = 8.661$, $p = .00$ (see Appendix A, Figure 1A). Specifically women with a psychiatric history reported higher levels of posttraumatic stress symptomatology ($M = 5.13$, $SE = 0.14$) than women without a psychiatric history ($M = 3.55$, $SE = 0.17$); and men with a psychiatric history reported higher levels of posttraumatic stress symptomatology ($M = 3.88$, $SE = 0.08$) than men without a psychiatric history ($M = 3.02$, $SE = 0.11$).

The interaction indicates that males reported lower PTSD symptomatology than females, irrespective of the presence of psychiatric history. Additionally, males with a psychiatric history reported elevated PTSD symptomatology compared to males without a psychiatric history. Similarly, females with no psychiatric history reported lower PTSD symptomatology compared to females with a psychiatric history. Further, the differences between the levels of PTSD symptomatology for males compared to females were larger for participants with a psychiatric history, than those without a psychiatric history (see Appendix B, Figure 2A).

There was significant interaction between gender and age for posttraumatic stress symptomatology, $F(1, 1089.37) = 7.651$, $p = .00$ (see Appendix B, Figure 2A). Additionally, with regards to anxiety, interaction analyses also revealed a significant interaction between gender and age, $F(1, 1035.49) = 4.44$, $p = .04$. Younger females reported elevated anxiety levels compared to older females, and compared to males of all ages. Additionally, older participants (irrespective of gender) indicated similar

levels of anxiety that were lower than the anxiety levels for younger groups (see Appendix C, Figure 3A).

Finally, interaction analyses revealed a significant interaction between gender and age $F(1, 1038.67) = 4.08$, $p = .04$; and gender and age with time $F(2, 1690.56) = 3.02$, $p = .05$, for depression (see Appendix D, Figure 4A). Specifically, females reported elevated depressive symptoms compared to males in all age groups. Younger females reported the highest depressive symptoms of any group (irrespective of gender or age) whereas younger males reported the lowest depressive symptoms of any group. Furthermore, the trends indicated that as age increased, depressive symptoms increased linearly for males; whereas as age increased, depressive symptoms decreased linearly for females.

Primary Analyses

Objective injury severity (ISS). Noting that ISS is a continuous variable, for the purposes of this analysis, ISS was evaluated by re-classifying it into three categories centred around: 1) the mean ('moderate severity'); 2) one standard deviation above the mean ('higher severity'); and 3) one standard deviation below the mean ('lower severity'). This occurred after taking into account the scale of the ISS (1-75), and was conducted in order to simplify an illustration of the impact of broader categories of injury severity on mental health outcomes. They are not diagnostic categories. There was a significant main effect of injury severity (ISS) for posttraumatic stress symptomatology only, $F(1, 1033.91) = 6.83$, $p = 0.01$), while levels of anxiety, $F(1, 978.83) = 1.62$, $p = .20$, and depression,, $F(1, 986.17) = 0.55$, $p = 0.46$, did not reach significance. Specifically, the results showed that individuals with

higher ISS scores (and therefore a greater injury severity level) reported more severe PTSD symptoms than those with moderate and lower PTSD scores.

Interaction analyses were also conducted to evaluate the impact of (the re-categorised) ISS on anxiety, depression and PTSD symptomatology over time. Results showed no significant interactions between sociodemographic variables and ISS for any of the mental health outcomes. Similar to the main effect results, a significant interaction was only identified between ISS and time for PTSD symptomatology, $F(2, 1778.34) = 4.46$, $p = .01$, indicating that the rate of change of PTSD symptom levels differed across the three time points between different ISS levels (see Figure 1). Analysis of the means indicates that although the overall trajectory of PTSD symptomatology is similar for different ISS levels across time, the rate of change in PTSD symptomatology between participants with various injury severities differs. Interaction analysis between ISS and time on anxiety and depression did not reach significance (see Appendix E, Figure 5A and 6A for details).

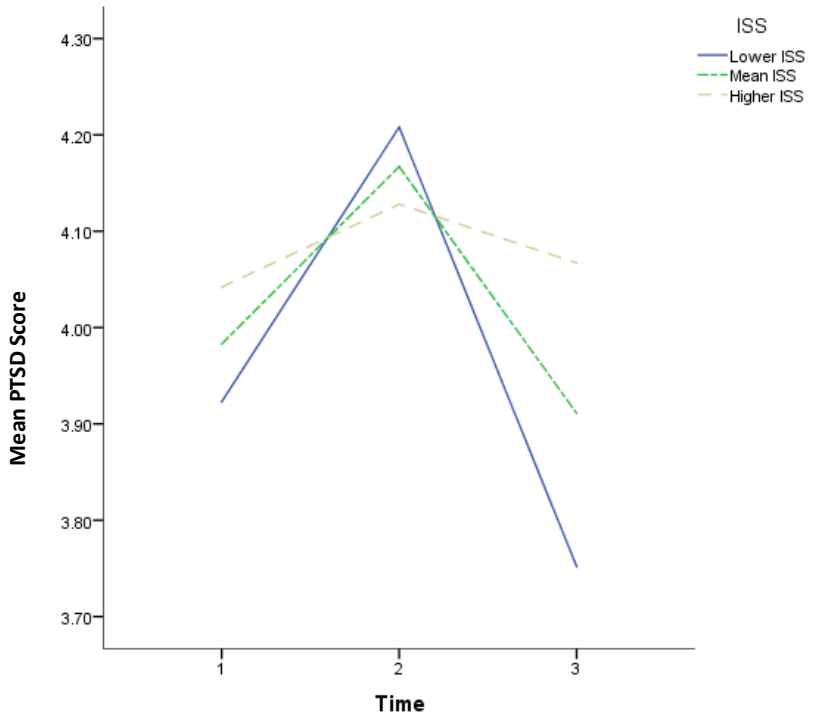

Figure 1. The significant interaction effect of ISS X Time on Posttraumatic Stress Symptomatology. 'Mean ISS' = mean of ISS; 'Lower ISS' = 1 SD below the mean of ISS; 'Higher ISS' = 1 SD above the mean.

Tests of simple effects of time were subsequently conducted in order to evaluate the effect of injury severity on changes in mental health outcomes over time. Results revealed a significant effect of Time within the moderate severity, $F(2, 1778.26) = 7.32$, $p = .00$, and lower severity categories, $F(2, 1787.25) = 11.11$, $p = .00$. Specifically, pairwise comparisons indicated that for individuals within the moderate range of injury severity, posttraumatic stress symptomatology levels were significantly higher at Time 2 than Time 1 (mean difference = 0.181, $SE = 0.08$, $p = .01$) and significantly higher at Time 2 than Time 3 (mean difference = 0.29, $SE = 0.08$, $p = .00$). Additionally, within the 'low severity' category, posttraumatic stress symptomatology levels were significantly higher at Time 2 than Time 1 (mean difference = 2.22, $SE = 0.09$, $p = .02$); significantly higher at Time 1 than Time 3

(mean difference = 0.27, *SE* = 0.10, *p* = .01); and significantly higher at Time 2 than Time 3 (mean difference = 0.491, *SE* = 0.104, *p* = .00). There was no significant difference in posttraumatic stress symptomatology between time points for the 'higher severity' category of ISS.

An additional measure of objective injury severity was calculated to assess severity of injury for particular sites, rather than using a global severity measure. These subsequent analyses could potentially inform the development of a more accurate final model. This subsequent analysis assessed a variant of severity specific to a given injury location based upon the maximum AIS severity rating (from 1 - 6) for each participant. The AIS was selected as the appropriate measure based upon its frequency of use within the literature, as well as in clinical and medical spheres; in addition to its relationship with the ISS development itself. Given the range of AIS scores, the scores were re-categorised for each injury according to the frequency of cases that experienced that particular severity level. This was to ensure the greatest generalisability of results, as the small number of cases at some severity levels had the potential to skew results. Head, abdomen, spine, upper extremity, and lower extremity were re-categorised into three categories: AIS score of 1, AIS score of 2 and AIS score of 3 or higher. Facial injury was re-categorised into two categories: AIS score of 1 and AIS score of 2 or higher. Finally, thorax injury was re-categorised into four categories: AIS score of 1, AIS score of 2, AIS score of 3 and AIS score of 4 or higher. In addition, external injuries were not tested as there was insufficient participants with severity above AIS 1 to produce meaningful results.

Based upon these re-categorisations, the results of a Time X Maximum (AIS) Severity interaction revealed only one significant effect: the impact of severity of facial

injury on PTSD symptomatology changed over time, $F(2, 1790.78) = 3.77$, $p = .02$. Specifically, participants with a more severe facial injury reported more severe PTSD symptoms across 12 months than individuals with a less severe facial injury. There were no other significant interactions.

As a consequence of this pattern of results evaluating objective injury severity using both the AIS and ISS outcome measures, and the emphasis in the literature on the frequency of use of the ISS, the Maximum AIS measure of objective severity measure was not included in the final model. However, the (significant) results established that ISS is a variable which warrants retention in further analyses/modelling, in order to comprehensively evaluate the primary aims of the study.

Injury Site. Main effect analyses evaluated the effect of having an injury in a specific site for each of the three mental health outcomes compared to not having an injury in that site (see Table 5). Results demonstrated a significant main effect between head injury and PTSD symptom severity, $F(1, 1049.38) = 20.33$, $p = .00$, indicating that individuals with a head injury had more severe PTSD symptoms than those without a head injury. Coefficient of determination effect size value, (r^2=0.01), however, indicated a low clinical significance. Participants with a facial injury also reported significantly greater PTSD symptom severity than those without a facial injury, $F(1, 1028.65) = 11.82$, $p = .00$. Coefficient of determination effect size value, (r^2=0.00), indicated a low clinical significance. Additionally, participants with external injury also reported statistically significantly greater PTSD symptom severity than participants without an external injury, $F(1, 1068.66) = 8.55$, $p = .00$, although the effect size value, (r^2=0.00) indicated a low clinical significance. Further, participants with a lower extremity injury reported significantly greater levels of depression than

participants without a lower extremity injury, $F(1, 991.95) = 7.19$, $p = .00$. The effect size value, (r^2=0.00), indicated a low clinical significance. Participants with an external injury also reported significantly greater levels of depression than participants without an external injury, $F(1, 1038.75) = 4.99$, $p = .03$. The effect size value, (r^2=0.01), indicated a low clinical significance.

Table 5

Main Effects of Injury Site on Anxiety, Depression, PTSD Symptom Severity

Variable	Anxiety			Depression			Posttraumatic Stress		
	F	*df*	*p*	*F*	*df*	*P*	*F*	*df*	*p*
Head	0.463	1012	.496	1.047	1021	.306	20.327	1049	.000**
Face	1.447	1638	.235	0.101	1011	.751	11.817	1029	.001**
Neck	1.538	869	.215	1.526	866	.217	3.518	1042	.061
Thorax	0.180	996	.672	2.814	1004	.094	0.023	1044	.880
Abdomen	0.057	988	.811	1.337	993	.248	0.231	1044	.631
Spine	0.893	985	.345	0.296	994	.587	1.251	1027	.264
Upper	0.131	989	.718	0.588	998	.444	0.374	1027	.541
Lower	0.536	985	.464	7.189	992	.007**	1.088	1030	.297

External	2.248	1025	.134	4.995	1039	.026*	8.551	1069	.004**

Note. Upper = upper extremity injury; Lower = lower extremity injury. **p< .01.

Mixed modelling interaction analyses were derived from variables retained from significant results from the analyses of earlier hypotheses. In this way, a final mixed model was tested, incorporating specific demographic variables (age, gender, psychiatric history) as well as objective injury severity and injury site for each of the three mental health outcomes. The results did not identify any notable differences or patterns from those illustrated in iterative steps within the model development process (that is, the described analyses and results thus far). The analyses and results regarding this final model are available in Appendix F.

Presence of injury as measured by 'number of injuries'. The hypothesis that the presence of injury would increase the likelihood of a poorer mental health outcome in a specific injury site (in comparison to an absence of an injury in that particular site) was tested using random intercept mixed modelling and evaluated with main effect analyses. The main effect analyses for this hypothesis incorporated the number of injuries in a specific site as its primary outcome measure. This would allow for additional information on the impact of the number/multiples of injuries on depression, anxiety and PTSD symptom severity, specifically comparing the impact of the presence of injury in a particular site to the impact of the absence of injury, as well as to the different number of injuries in that particular site. Whilst this particular outcome measure could also be viewed as a measure of injury severity, in this case its inclusion emphasised the evaluation of the presence of injury hypothesis, as well as extending

the findings of this hypothesis by including greater detail on the impact of the number/multiples of injuries on each mental health outcome.

A significant main effect was demonstrated between head injury and PTSD symptom severity, $F(2, 1036.04) = 7.83$, $p = .00$, (r^2=0.00, indicating a low clinical significance). Pairwise comparisons indicated that participants with one head injury reported a significantly higher PTSD symptom severity score than those with no head injury (mean difference = 0.66, *SE* = 0.17 $p = .00$). Notably, there was no significant difference for PTSD symptom severity for participants with one head injury, compared to participants with two or more head injuries (mean difference = 0.43, *SE* = 0.34, $p = .21$). Thus, the hypothesis was partially supported regarding head injury and PTSD only; and therefore disconfirmed regarding head injury with both anxiety and depression whereby the results did not indicate a significant relationship.

Results also revealed a significant main effect of lower extremity injury for depression, $F(4, 979.08) = 3.78$, $p = .01$, (r^2=0.00, indicating a low clinical significance). Pairwise comparisons indicated that participants with two lower extremity injuries reported more severe depression levels than participants with no lower extremity injuries (mean difference = 0.24, *SE* = 0.09, $p = .00$). Further, participants with three lower extremity injuries reported a significantly higher depression level than participants with no lower extremity injuries (mean difference = 0.36, *SE* = 0.13, $p = .00$); and participants with four or more lower extremity injuries reported a significantly higher depression level than participants with no lower extremity injuries (mean difference =0.27, *SE* = 0.11, $p = .02$). Lastly, participants with three lower extremity injuries reported a significantly higher depression level than participants with one lower extremity injury (mean difference = 0.28, *SE* = 0.13, $p =$

.03). This mixed pattern of significant differences largely indicated that having two or more lower extremity injuries was associated with a significantly higher level of depression than having no lower extremity injuries. Lower extremity injury and PTSD symptom severity did not reach significance.

Results revealed a significant main effect of lower extremity injury on anxiety, $F(4, 980.69) = 3.14$, $p = .01$, (r^2=0.00, indicating a low clinical significance). Pairwise comparisons indicated a mixed picture of significant results with no discernible pattern, whereby individuals with one lower extremity injury reported significantly lower anxiety levels than participants with no lower extremity injury (mean difference = -0.20, $SE = 0.08$, $p = .01$). Further, participants with three lower extremity injuries reported a significantly higher anxiety level than participants with one lower extremity injury (mean difference = 0.46, $SE = 0.14$, $p = .00$); and participants with three lower extremity injuries reported a significantly higher anxiety level than participants with two lower extremity injuries (mean difference = 0.31, $SE = 0.15$, $p = .04$). This mixed pattern of significant differences disputed the hypothesis as there is no consistent relationship between the presence of (any number of) lower extremity injuries and mental health outcome.

Results of main effect analyses demonstrated a statistically significant effect for external injuries on PTSD symptom severity scores, $F(2,1059.62) = 4.34$, $p = .01$, (r^2=0.00, indicating a low clinical significance). Pairwise comparisons indicated that participants with two external injuries reported a significantly higher PTSD symptom score than participants with no external injuries (mean difference = 0.86, $SE = 0.36$, $p = .02$). Notably, there was no significant difference on PTSD symptom severity for participants with one external injury, compared to participants with two or more

external injuries (mean difference = 0.38, *SE* = 0.42, *p* = .37). Again, this hypothesis was only partially met, given there were no significant results regarding anxiety.

Further, there was a significant main effect of external injuries on depression, *F*(2, 1028.34) = 3.08, *p* = .046, (r^2=0.00, indicating a low clinical significance). Analysis indicated a significant main effect of the number of external injuries on depression levels, such that participants with a greater number of external injuries reported a higher depression level. Pairwise comparisons did not, however, demonstrate any significant simple effects within numerical categories on depression.

Table 6

Main Effect of Presence of Injury in a Specific Injury Site on Anxiety, Depression and PTSD Symptom Severity

Variable	Anxiety			Depression			Posttraumatic Stress		
	F	*df*	*P*	*F*	*df*	*P*	*F*	*df*	*P*
Head	0.163	994	.849	2.304	990	.010	7.838	1036	.000**
Face	0.344	1014	.793	0.423	1011	.730	2.060	1048	.104
Thorax	0.660	1025	0.517	0.845	1027	.430	0.470	1054	.619
Abdomen	0.212	1026	.809	0.029	1026	.972	2.183	1065	.113
Spine	1.341	990	0.260	0.482	986	.695	2.480	1045	.896
Upper	0.046	996	.996	0.186	992	.946	0.272	1045	.896
Lower	3.142	981	.014*	3.787	980	.005**	1.583	1024	.177
External	1.111	1027	.330	3.079	1028	.046*	4.338	1060	.013*

Note. 0 = no injury in the particular site, 1 = presence of one injury in the specific site, 2+ presence of two or more injuries in the specific site, 3 = presence of three injuries in the specific site, 4+ = presence of four or more injuries in the specific site; SE = standard error; *p< .05; **p< .01

This variant of severity (that is, the number of injuries within the specific injury site) was subsequently not included in the final model. This was determined by the results of the analysis which indicated that the number of injuries did not significantly contribute any further impact or information for mental health outcomes beyond the variable pertaining specifically to the presence (variable 'YN') of injury that was evaluated within the earlier analyses of injury.

3.5 Discussion

The primary objective of the current study was to investigate the relationships between both injury site and the objective severity of traumatic injury with depression, anxiety and PTSD symptom severity over a 12 month period. In particular, three hypothesis were tested. Preliminary analyses showed that sociodemographic variables were associated with mental health outcomes. Specifically, female gender and the presence of a psychiatric history were related to elevated anxiety, depression and PTSD symptom severity and younger age was related to worse anxiety and PTSD symptom severity. These associations are largely in line with the body of research linking specific sociodemographic factors with mental health impact (Creamer et al., 2001; Ozer, Best, Lipsey, & Weiss, 2003; Steel et al., 2011) and therefore serve to provide confidence in the analytic and methodological considerations used throughout this study. Interestingly, the inclusion of these variables in the later stages of modelling did not additionally contribute to, nor impact, the outcomes of interactions with injury site. Furthermore, the results were also not consistent across each mental health outcome. This may reflect that the contributions of site, severity and demographics to each mental health outcome is unique, as opposed to being common or cumulative.

The first part of our primary investigation evaluated the associations between objective injury severity and mental health outcomes, wherein objective injury severity was only expected to be associated with elevated PTSD symptoms, but not with anxiety or depression. Consistent with this prediction, results demonstrated a significant relationship for PTSD symptoms, such that participants with more severe injury reported higher PTSD symptom severity over time, compared to participants with a less severe injury. This pattern was not replicated with anxiety nor depression, suggesting that objective injury severity is not a consistent predictor for each individual mental health outcome after traumatic injury. Furthermore, the implementation of an additional measure of objective severity (that is, analyses using a Maximum AIS score or the number of injuries in a specific site as a measure of severity) showed inconsistent patterns to those exhibited by the ISS analyses. This outcome is consistent with much of the previous research suggesting that objective measures of injury severity are not wholly indicative of mental health outcome and therefore that other measures, including subjective measures of severity, may be more clinically useful (Gabert-Quillen et al., 2011; Kreis et al., 2011; Mason et al., 2006; Quale & Schanke, 2010).

The significant relationship between severity of injury and PTSD symptomatology may be partially explained through COR theory (Hobfoll, 1989; Hobfoll, 2002); such that greater severity of injury leads to greater resource loss and subsequent decline in mental health outcome, which in this instance is PTSD symptomatology. However, this alignment with COR theory cannot account for the overall pattern of findings, as this significant result was not replicated with anxiety or depression outcomes. Additionally, the results also do not fully concur with the

transdiagnostic model, through which, all three outcomes would have been expected to be related to a latent structure suggestive of a general negative affect vulnerability, rather than a singular pathway to a specific disorder (Barlow et al., 2004). If this latent variable for general negative affect was responsible for the association between injury severity and mental health outcome, a significant relationship between each of the three mental health outcomes would be evident. Thus, the result that the relationship is evident for only one of the outcome measures (PTSD symptomatology) that the result is not due to a common underlying construct or etiological pathway. It is, however, likely that this outcome is related to a cognitive theory of PTSD development, in which the individual's appraisal of the event (injury) and themselves, heavily influences the development of PTSD symptoms (Ehlers and Clarke, 2000). It may be the case that these findings reflect that the individual's perception of threat and their coping self-efficacy negatively impacted their processing and post-injury adjustment.

The third evaluation assessed the impact of site of injury on mental health outcomes over a 12 month period. Based on previous literature (Weaver et al., 2014a, Weaver et al., 2014b., Ehlers and Clark 2001, Briere 2006, Fukunishi 1999, Madianos et al.,2001), it was hypothesised that specific injury sites whose disfigurement would be more evident to or visible to the general public, would be associated with depression and/or PTSD symptom severity. These sites were hypothesised to include head, face, external injury and upper and lower extremities. Whilst the results did not demonstrate a uniform relationship between individual sites of injury and the three mental health outcomes, they exhibited a mixed pattern of findings that was largely consistent with the hypothesis. Consistent with the hypothesis, head injury was associated with worse PTSD symptom severity outcome such that individuals with a head injury had more

severe PTSD symptoms than those without a head injury; and participants with a facial injury also reported significantly greater PTSD symptom severity than those without a facial injury. This association between facial injury and PTSD is consistent with prior findings which have suggested that the underlying mechanism of disfigurement, leading to body image distress, is the causal instrument in the development of PTSD, rather than the (facial) location of the injury itself (Fukunishi, 1999; Glynn et al., 2010; Madianos et al., 2001). Participants with external injury also reported significantly greater PTSD symptom severity and depression than participants without an external injury. It may be the case that head, face and external injury are at greater risk of disfigurement than other sites. However, given disfigurement itself was not a variable in the current study, it would be useful in future research to explore the mediating effect of disfigurement on the impact of site of injury. Lastly, lower (but not upper) extremity injury was associated with higher levels of depression and anxiety in participants when compared to individuals without that injury. This is likely to be partially reflective of functional capacity and implications on daily life activities.

An alternative explanation for the site findings may lie within the theoretical framework of cognitive models of trauma development. As well as functional inhibitions in activities of daily life, the findings from the current study that some specific sites are associated with poorer mental health outcome are consistent with cognitive psychological theories, in which the negative appraisal and beliefs of the individual disfigurement and loss of function are causal to the development of mental health symptomatology (Ehlers and Clark, 2000). Injury can result in acute or long-term appearance changes. Individuals with injury-related appearance changes may form psychological meanings attached to the physical alterations, or be influenced by

previous belief systems regarding altered physical appearances. These meanings and appraisals may be related to the appearance change or the context on which the injury occurred (Weaver, Turner, Schwarze, Thayer & Carter-Sand 2007) resulting in body image distress, which in turn emphasises the importance of cognitive appraisal in influencing the trajectory of traumatic injury adjustment. Participants in both of Weaver et al.'s (2014b) study on soldiers who sustained injury in a combat-related deployment and their 2014a study exploring women who experienced violence in interpersonal intimate relationships, described injuries leading to scarring around the face, stomach, arms and head. In each study, participants anchored their body image distress concerns to the injury-related appearance change. Thus, findings from the current study that head, face, lower extremity injury and external injuries are associated with higher psychological symptomatology, may be reflective of the negative body image amplified by the visibility of the specific sites identified – that is, that the aforementioned sites are highly visible to the general public – and in this way, through the cognitive appraisal, can influence post-injury adjustment.

Fewer associations reached significance when assessed over the full 12 month interval in the final interaction model. First, thorax injuries were found to be significantly related to depression over time, although these results must be interpreted in light of statistical correlation between thorax and other injury sites. Secondly, although not replicated for anxiety and depression, participants with facial injuries reported significantly higher levels of PTSD symptomatology over time compared with individuals with other types of injury.

Similarly to the conceptual implications of the sociodemographic results discussed above, the inconsistent pattern of results for depression, anxiety and PTSD

symptomatology do not cleanly support the transdiagnostic model of mental health constructs. However, although each site was not uniformly associated with all three mental health outcomes, the current data does not allow for an understanding of how many people reported comorbidity. Thus, it may be the case that, (whilst beyond the scope of the current study), the inclusion of comorbidity variables may actually exhibit greater alignment with transdiagnostic models, than our current data is capable of showing.

It was lastly predicted that the presence of any injury (irrespective of its body site) would be associated with poorer mental health across time, when compared to an absence of that same injury. Results indicated only partial support for this hypothesis; specifically that presence of a head injury was associated with greater PTSD symptom severity than the absence of head injury; that having one or more lower extremity injuries was associated with a significantly higher level of depression and anxiety than having no lower extremity injuries; and that external injury was associated with worse depression and PTSD symptom severity. This general pattern of results, whereby the presence of (any) injury was frequently associated with increased symptomatology for each of the three mental health outcomes, is concordant with previous research (Bernat et al., 1998; Delahanty et al., 2003; Gabert-Quillen et al., 2011; Koen et al., 2005) and may be explained in part by the COR conceptual model (Hobfoll, 1989; Hobfoll, 2002). This is because (notwithstanding the severity, extent or site of injury), the presence of injury both leads to, and is representative of, a 'resource loss', which in turn results in a negative impact on mental health.

Overall, the variables assessed in this study appear to be more consistently related to severity of PTSD symptoms than to anxiety and depression, albeit noting that

effect sizes for all significant analyses were low. When drawing together the conceptual alignment from each iterative component of our modelling process with both the COR and transdiagnostic theories, it appears that neither theory provides an overall comprehensive understanding of the pattern of outcomes, but that cognitive models of trauma may in fact provide some understanding. The pattern of results – and the more frequent relationship between our tested variables and PTSD - may also be reflective of methodological considerations. In particular, the use of the HADS to measure anxiety and depression, in contrast to the use of the CAPS, a diagnostic interview to measure PTSD, may have in part influenced outcomes. The psychometric properties of the HADS and its exclusion of somatic symptomatology have often led to its preferential use as a screen for emotional distress (Vodermaier & Millman, 2011), however more recently its utility for diagnostic caseness of both depression and anxiety has been questioned (Martin, 2005). This is due to the previously assumed bi-dimensionality being reviewed in favour of a tridimensional factor structure (with dimensions of anhedonia, negative affectivity and autonomic arousal; Martin, 2005). Furthermore, the reliance on self-report measures that assess levels of symptomatology (such as the HADS) can limit diagnostic interpretability (Mason, Wardrope, Turpin, & Rowlands, 2002), as differing thresholds of caseness have been observed between many studies, which in turn serves to cloud accurate results (Blaszczynski et al., 1998). By comparison, use of a clinical interview such as the CAPS to assess PTSD has proven to be an effective and reliable measure (Weathers, Keane, & Davidson, 2001). Thus in this study, the difference between the use of a consistent self-report measurement tool for anxiety and depression, and a clinical interview for PTSD, as well as the strengths and weaknesses of each of the tools, may have affected the pattern of results.

Clinically, these results can contribute to current practice regarding the implementation of screening and early intervention following traumatic injury. The finding that the presence of any injury is likely to negatively impact mental health indicates that patients admitted to hospital with a traumatic injury should be screened and routinely monitored for risk indicators of anxiety, depression and PTSD, in accordance with Bisson and Cohen's (2006) 'watchful waiting' recommendations, and subsequently guided to treatment if appropriate. By incorporating the significant predictors of symptomatology identified in this study (e.g., presence of head, face, external and lower extremity injury, younger age, female gender and pre-injury psychiatric history), stronger and more accurate screening tools may be developed and in turn, facilitate appropriate implementation of early intervention (O'Donnell et al., 2008; Richmond et al., 2011).

Recent research suggests that PTSD/sub-syndromal PTSD and depression in the first three months after injury significantly increase the risk of disability at 12 months after injury (O'Donnell et al., 2009). In line with these results, findings from the present study aligning severity of injury with increased PTSD symptomatology over time suggest that the use of severity of injury in a screening tool for PTSD may in turn assist in mitigating the development of long-term disability. In this way, the inclusion of physical injury characteristics as vulnerability factors in screening tools can be used to direct early intervention and reduce the likelihood of disability and longer-term social and psychological effects. However, given that objective injury severity was associated with PTSD and not anxiety and depression, it is recommended that the inclusion (specifically) of the ISS and other objective severity measures alone is carefully considered, or used with caution in predicting mental health outcomes.

Perhaps instead, as suggested by Gabert-Quillen et al. (2011), inclusion of a subjective measure of injury severity as well as the objective measure might provide more reliable and predictive information on longitudinal mental health outcomes; a future study that could beneficially inform the development of screening tools further.

Several shortcomings of the current study need to be considered, which may limit generalisability of findings. Findings were based upon a mixture of clinical interview (for PTSD symptom severity) and self-report (for anxiety and depression), leaving the data open to possible response bias. As noted previously, this difference in assessment methodology might also account for differences in the pattern of results between PTSD, anxiety, and depression. Further, Traumatic Brain Injury (TBI) has been regularly associated with PTSD both as a confounding variable and in frequent comorbidity. The current study excluded participants with moderate or above levels of TBI due to the complexity of its relationship with PTSD; however this exclusion may limit generalizability of findings to broader injury populations. Additionally, variables which were not tested in the current study may help also help to explain the current findings, such as disfigurement and functional impact. The inclusions of these covariates in future studies might assist in clarifying the contribution of both combined and separate physical and psychological injury characteristics on each mental health outcome.

Furthermore, the nature of the parent dataset precluded the use of clinical caseness for the current study, in favour of measures of symptomatology. Had clinical caseness been able to be incorporated into the design, in addition to measures of symptomatology, a more holistic understanding of the extent of symptomatology may have contributed further understanding to the domain, in particular the delineated

symptom profiles of the three mental health outcomes. Further, covariates which have been suggested to affect mental health outcome (such as coping self-efficacy, pain and functional impairment; De-Roon Cassini et al., 2011) were also beyond the scope of the current study and therefore not included in the model. A final consideration is the type of trauma, or mechanism of injury that may not only have given rise to different injuries, but may also have given rise to different mental health outcomes. For example, interpersonal violence has regularly been implicated in poor post-traumatic adjustment (Ozer et al., 2003). It is therefore possible that the inclusion of mechanism of injury could have changed the pattern of results; and if included in future studies, could provide a more comprehensive model.

The aim of this study was to investigate the impact of objective injury characteristics on mental health outcomes following traumatic injury. The development and selection of the components of the final statistical model were therefore built upon an iterative empirical process. Given the pattern of results from the current study, future work that includes both objective injury characteristics and subjective covariates may provide further information and a potentially significant evaluative comparison between the two. Additionally, whilst acknowledging the prevalence of comorbidity in the literature (Blanchard et al., 2004; Bryant et al., 2010; O'Donnell et al., 2004), its inclusion was beyond the scope of the current study. Noting the concordance of psychological comorbidity between anxiety, depression and PTSD, as well as recent transdiagnostic approaches suggesting a structural similarity (Barlow et al., 2004; Grant et al., 2008), the evaluation of comorbid outcomes could be of clinical, conceptual and theoretical interest in future research.

Despite these limitations, this study extends the traumatic injury literature in its investigation of site and/or severity of injury as predictors of depression, anxiety and PTSD symptom severity over a 12 month period following a traumatic injury, using a large heterogeneous, traumatically injured sample with a prospective longitudinal design. The key findings, that the presence of injury is more frequently predictive of mental health outcome severity than the objective severity of injury; that injury in some specific sites (head, face, external and lower extremity) is associated differently with individual mental health outcomes, and; that objective injury severity is important for PTSD symptom severity but less so for anxiety and depression, provide a solid foundation for future research to focus on additional injury characteristics as predictors of mental health outcomes. In order to extend the findings of the current study, it is recommended that future work could incorporate comorbidity as an additional and comparative outcome measure; and that the inclusion of subjective covariates (such as pain, subjective distress or coping self-efficacy) as well as objective predictor injury characteristics, would provide additional depth to the current findings. Overall, the results support the exclusion of the use of stand-alone objective severity measures as predictors of mental health outcome (perhaps in turn indicating a need for a new physical injury coding system) and highlight the importance of the presence of injury, above the severity, number or sites of injuries, on the impact on mental health outcomes.

3.6 References

American Congress of Rehabilitation Medicine. Definition of mild traumatic brain injury. *Journal of Head and Trauma Rehabilitation, 1993,* 8, 86-87.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., Text Revision). Washington, DC.

Andrews, B., Brewin, C.R., Rose, S., & Kirk, M. (2000). Predicting PTSD symptoms in victims of violent crime: the role of shame, anger and childhood abuse. *Journal of Abnormal Psychology, 109,* 69-73.

Baker, S.P., O'Neill, B., Haddon, W., & Long, W.B. (1974). The Injury Severity Score: A method for describing patents with multiple injuries and evaluating emergency care. *Journal of Trauma, 14*(3), 187-196.

Baker, S.P., & O'Neill, B. (1976). The Injury Severity Score: An update. *The Journal of Trauma, 16*(11), 885-885.

Barlow, D.H., Allen, L.B., & Choate, M.L. (2004). Toward a unified treatment for emotional disorders. *Behaviour Therapy, 35,* 205-230.

Bernat, J.A., Ronfeldt, H.M., Calhoun, K.S., & Arias, I. (1998). Prevalence of traumatic events and peritraumatic predictors of posttraumatic stress symptoms in a nonclinical sample of college students. *Journal of Traumatic Stress, 11*(4), 645-664.

Bisson, J.I., & Cohen., J.A. (2006). Disseminating early interventions following trauma. *Journal of Traumatic Stress*, 19(5), 583-595.

Bjelland, I., Dahl, A.A., Haug, T.T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated literature view. *Journal of Psychosomatic Research, 52*(2), 69-77.

Blake, D.D., Weathers, F., Nagy, L.M., Kaloupek, D.G., Gusman, F.D., Charney, D.S., & Keane, T.M. (1995). The development of a clinician administered PTSD scale. *Journal of Traumatic Stress, 8*(1), 75-90.

Blanchard, E.B., Hickling, E.J., Freidenberg, B.M., Malt, L.S., Kuhn, E., & Sykes, M.A. (2004). Two studies of psychiatric morbidity after motor vehicle accident survivors 1 year after the crash. *Behaviour Research and Therapy, 42,* 569-583.

Blaszczynski, A., Gordon, K., Silove, D., Sloane, D., Hillman, K., & Panasetis, P. (1998). Psychiatric morbidity following motor vehicle accidents: A review of methodological issues. *Comprehensive Psychiatry, 39*(3), 111-121.

Bonanno, G.A., Kennedy, P., Galatzer-Levy, I.R., Lude, P., & Elfstrom, M.L. (2012). Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabilitation Psychology, 57*(93), 236-247.

Bonanno, G.A., & Mancini, A.D. (2012). Beyond resilience and PTSD: Mapping the heterogeneity of response to potential trauma. *Psychological Trauma: Theory, Research, Practice & Policy, 4*(1), 74-83.

Breslau, N., Davis, G.C., Andreski, P., & Peterson, E. (1991). Traumatic events and posttraumatic stress disorder in an urban population of young adults. *Archives of General Psychiatry, 48,* 216-222.

Breslau, N., Davis, G.C., Peterson, E.L., & Schultz, L.R. (2000). A second look at comorbidity in victims of trauma: The posttraumatic stress disorder – major depression connection. *Biological Psychiatry, 48,* 902-909.

Breslau, N., Kessler, R.C., Chilcoat, H.D., Schultz, L.R., Davis, G.C., Andreski, P. (1998). Trauma and posttraumatic stress disorder in the community: the 1996 Detroit Area Survey of Trauma. *Archives of General Psychiatry, 55*, 626-632.

Briere, J. (2006). Dissociative symptoms and trauma exposure: Specificity, affect dysregulation, and posttraumatic stress. *Journal of Nervous and Mental Disease, 194,* 78-82.

Bromet, E., Sonnega, A., & Kessler, R.C. (1998). Risk factors for DSM-III-R posttraumatic stress disorder: Findings from the National Comorbidity Survey. *American Journal of Epidemiology, 147,* 353-361.

Bryant, R.A. (2011). Mental disorders and traumatic injury. *Depression and Anxiety, 28,* 99-102.

Bryant, R.A., Creamer, M., O'Donnell, M.L., Silove, D., & McFarlane, A.C. (2010). Sleep disturbance immediately prior to trauma predicts subsequent psychiatric disorder. *Sleep, 33*(1), 69-74.

Bryant, R.A., O'Donnell, M.L., Creamer, M.C., McFarlane, A.C., Clark, C.R., & Silove, D. (2010). The psychiatric sequelae of traumatic injury. *American Journal of Psychiatry, 167*, 312-320.

Cameron, C., Purdie, D.M., Kliewer, E.V., & McClure, R.J. (2006). Mental health: A cause or consequence of injury? A population-based matched cohort study. *BMC Public Health, 6,* 114-123.

Chorpita, B.F., Albano, A.M., & Barlow, D.H. (1998). The structure of negative emotions in a clinical sample of children and adolescents. *Journal of Abnormal Child Psychology, 107,* 74-85.

Clark, L.A. (2005). Temperament as a unifying concept in the study if personality and psychopathology. *Journal of Abnormal Psychology, 114,* 505-521.

Clark, L.A., & Watson, D. (1991). Tripartite model of anxiety and depression: psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology, 101,* 103-116.

Cox, B.J., Clara, I.P., & Enns, M.W. (2002). Posttraumatic stress disorder and the structure of common mental disorders. *Depression and Anxiety, 15,* 168-171.

Craske, M.G. (2012). Transdiagnostic treatment for anxiety and depression. *Depression and Anxiety, 29,* 749-753.

Creamer, M., Burgess, P., McFarlane, A.C. (2001). Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychological Medicine, 31,* 1237-1247.

Davydow, D.S., Zatzick, D.F., Ruvara, F.P., Jurkovich, G.J., Wang, J., Roy-Byrne, P.P., Katon, W.K., Hough, C.L., Kross, E.K., Fan, M., Joesch, J., Mackenzie, E.J. (2009). Predictors of posttraumatic stress disorder and return to usual major activity in traumatically injured intensive care unit survivors. *General Hospital Psychiatry, 31,* 428-435.

Delahanty, D.L., Raimonde, A.J., Spoonster, E., & Cullado, M. (2003). Injury severity, prior trauma history, urinary cortisol levels, and acute PTSD in motor vehicle accident victims. *Journal of Anxiety Disorders, 17*(2), 149-164.

Deshields, T., Tibbs, T., Fan, M.Y., & Taylor, M. (2006). Differences in patterns of depression after treatment for breast cancer. *Psychooncology, 15,* 398-406.

deRoon-Cassini, T.A., Mancini, A.D., Rusch, M.D., & Bonanno, G.A. (2010). Psychopathology and resilience following traumatic injury: A latent growth mixture model analysis. *Rehabilitation Psychology, 55*(1), 1-11.Doron-LaMarca, S., Vogt, D.S., Saxe, G.N., King, D.W., & King, L.A. (2010). Pretrauma problems, prior stress exposure, and gender as predictors of change in posttraumatic stress symptoms among physically injured children and adolescents. *Journal of Consulting and Clinical Psychology, 78*(6), 781-793.

Dougall, A.L., Ursano, R.J., Posluszny, D.M., Fullerton, C.S., & Baum, A. (2001). Predictors of posttraumatic stress among victims of motor vehicle accidents. *Psychosomatic Medicine, 63*(3), 402-411.

Dunmore, E., Clark, D.M., & Ehlers, A. (2001). A prospective investigation of the role of cognitive factors in persistent Posttraumatic Stress Disorder (PTSD) after physical and sexual assault. *Behaviour Research and Theory, 38,* 319-345.

Ehlers, A., & Clark, D.M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38*, 319-345.

Ehlers, A., Mayou, R.A., & Bryant, B. (1998). Psychological predictors of chronic posttraumatic stress disorder after motor vehicle accidents. *Journal of Abnormal Psychology, 107*, 508-519.

Ehlers, A., Mayou, R.A., & Bryant, B. (1998). Psychological predictors of chronic posttraumatic stress disorder after motor vehicle accidents. *Journal of Abnormal Psychology, 107*, 508-519.

Elhai, J.D, de Francisco Carvalho, L., Miguel, F.K., Palmieri, P.A., Primi, R., & Frueh, B.C. (2011). Testing whether posttraumatic stress disorder and major depressive disorder are similar or unique constructs. *Journal of Anxiety Disorders, 25,* 404-410.

Fanous, A., Gardner, C.O., & Prescott, C.A. (2002). Neuroticism, major depression and gender: a population-based twin study. *Psychological Medicine, 32,* 718-728.

Freedy, J.R., Saladin, M.E, Kilpatrick, D.G., Resnick, H.S., & Saunders, B.E. (1994). Understanding acute psychological distress following natural disaster. *Journal of Traumatic Stress, 7,* 257-273.

Frommberger, U.H., Stieglitz, R.D., Nyberg, E., Schlickewei, W., Kuner, E., & Berger, M. (1998). Prediction of posttraumatic stress disorder by immediate reactions to trauma: A prospective study in road traffic accident victims. *European Archives of Psychiatry and Clinical Neuroscience, 248*(6), 316-321.

Fuglsang, A.K. (2000). The relationship between the acute traumatic reactions and PTSD – An overview. *Nordisk Psykologi, 52*(2), 95-113.

Fukunishi, I. (1999). Relationship of cosmetic disfigurement to the severity of posttraumatic stress disorder in burn injury or digital amputation. *Psychotherapy and Psychosomatics, 68,* 82-86.

Gabert-Quillen, C.A., Fallon, W., & Delahanty, D.L. (2011). PTSD after traumatic injury: An investigation of the impact of injury severity and peritraumatic moderators. *Journal of Health Psychology, 16*(4), 678-687.

Gerstof, D., Herlitz, A., & Smith, J. (2006). Stability of sex differences in cognition in advanced age: The role of attrition and education. J*ournals of Gerontology, Series B: Psychological Sciences and Social Sciences, 61,* 245-249.

Glynn, S. M., Shetty, V., & Dent, M. (2010). The long-term psychological sequelae of orofacial injury. *Oral Maxillofacial Surgery Clinical North America, 22*(2), 217-224.

Grandey, A.A., & Cropanzano, R. (1999). The conservation of resources model applied to work-family conflict and strain. *Journal of Vocational Behaviour, 54,* 1-21.

Grant, D.M., Beck, J.G., Marques, L., Palyo, S.A., & Clapp, J.D. (2008). The structure of distress following trauma: posttraumatic stress disorder, major depressive disorder, and generalised anxiety disorder. *Journal of Abnormal Psychology, 17*(3), 662-672.

Grieger, T.A., Cozza, S.J., Ursano, R.J., Hoge, C., Martinez, P.E., Engel, C.C., Wain, H.J. (2006). Posttraumatic stress disorder and depression in battle-injured soldiers. *American Journal of Psychiatry, 163,* 1777-1783.

Gros, D.F., Magruder, K.M., Ruggiero, K.J., Shaftman, S.R., & Frueh, B.C. (2012). Comparing the symptoms of posttraumatic stress disorder with the distress and fear disorders. *The Journal of Nervous and Mental Disease, 200*(11), 967-972.

Gros, D.F., Price, M., Magruder, K.M., & Frueh, B.C. (2012). Symptom overlap in posttraumatic stress disorder and major depression. *Psychiatry Research, 196,* 267-270.

Haagsama, J.A., Ringburg, A.N., van Lieshout, E.M., van Beeck, E.F., Patka, I.B., & Polinder, S. (2012). Prevalence rate, predictors and long-term course of probably posttraumatic disorder after major trauma: a prospective cohort study. *Biomed Central Psychiatry, 12,* 236-245.

Harris, I.A., Young, J.M., Rae, H., Jalaludin, B.B., & Solomon, M.J. (2008). Predictors of posttraumatic stress disorder following major trauma. *ANZ Journal of Surgery, 78,* 583-587.

Hobfoll, S.E. (1989). Conservation of Resources: A new attempt at conceptualising stress. *American Psychologist, 44*(3), 513-524.

Hobfoll, S.E. (2002). Social and psychological resources and adaptation. *Review of General Psychology, 6*(4), 307-324.

Holbrook, T.L., Hoyt, D.B., Stein, M.B., & Sieber, W.J. (2002). Gender differences in long-term posttraumatic stress disorder outcomes after major trauma: Women are at higher risk of adverse outcomes than men. *The Journal of Trauma, 53*(5), 882-888.

Holtslag, H.R., Post, M.W., Lindeman, E., & van der Werken, C. (2007). Long-term functional health status of severely injured patients. *Injury, 38,* 280-289.

Holtslag, H.R van Beeck, E.F., Lindeman, E., Leenan, L.P.H. (2007). Determinants of long-term functional consequences after major trauma. *The Journal of Trauma: Injury, Infection and Critical Care, 62*(4), 919-927.

Horowitz, M., Wilmner, N., & Alvarez, W. (1979). Impact of Events Scale: a measure of subjective stress. *Psychomotor Medicine, 41*(3), 209-218.

Ironson, G., Wynings, C., Schniederman, N., Baum, A., Rodrigues, M., & Greenwood, D. (1997). Post-traumatic stress symptoms, intrusive thoughts, loss, and immune function after Hurricane Andrew. *Psychosomatic Medicine, 59,* 128-141.

Jacqmin-Gadda, H., Fabrigoule, C., Commenges, D., & Dartigues, J.F. (1997). A 5- year longitudinal study of the Mini-Mental State Examinatrion in normal ageing. *American Journal of Epidemiology, 145,* 498-506.

Jeavons, S. (2000). Predicting who suffers from psychological trauma in the first year after a road accident. *Behaviour Research and Therapy, 38*(5), 499-508.

Kendler, K.S, Gardner, C.O., & Prescott, C.A. (2002). Toward a comprehensive developmental model for major depression in women. *American Journal of Psychiatry, 168*, 68-75.

Keogh, E., & Reidy, J. (2000). Exploring the factor structure of the Mood and Anxiety Symptom Questionnaire (MSQ). *Journal of Personality Assessment, 74*(1), 106-125.

Kessler, R.C., Sonnega, A., Hughes, M., Nelson, C.B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, *52*, 1048-1060.

Kessler, R.C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K.R, Rush, A.J., Walters, E.E., & Wang, P.S. (2003). The epidemiology of major depressive disorder: Results from the National Comorbidity Survey Replication. *Journal of the American Medical Association, 289*(23), 3095-3105.

King, D.W., King, L.A., Foy, D.W., Keane, T.M., & Fairbank, J.A. (1999). Posttraumatic stress disorder in a national sample of female and male Vietnam veterans: Risk factors, war-zone stressors, and resilience-recovery variables. *Journal of Abnormal Psychology, 108,* 164-170.

Koren, D., Arnon, I., & Klein, E. (1999). Acute stress response and posttraumatic stress disorder in traffic accident victims: A one year prospective, follow-up study. *American Journal of Psychiatry, 156*(3), 367-373.

Koren, D., Norman, D., Cohen, A., Berman, J. & Klein, E.M. (2005). Increased PTSD risk with combat-related injury: A matched comparison study of injured and uninjured soldiers experiencing the same combat events. *American Journal of Psychiatry, 162*(2), 276-282.

Kreis, B.E., Castano, N.J.Y., Tuinebreijer, W.E., Hoogenboom, L.C.A., Meylaerts, S.A.G., & Rhemrev, S.J. (2011). Characteristics of polytrauma patients with posttraumatic stress disorder in a level 1 trauma center. *European Journal of Trauma and Emergency Surgery, 37,* 269-275.

Krueger, R.F., Watson, D., & Barlow, D.H. (2005). Toward a dimensionally based taxonomy of psychopathology. *Journal of Abnormal Psychology, 114,* 491-493.

Laugharne, J., Lillee, A., & Janca, A. (2010). Role of psychological trauma in the cause and treatment of anxiety and depressive disorders. *Current Opinion in Psychiatry, 23,* 25-29.

Lavoie, A., Moore, L., LeSage, N., Liberman, M., & Sampalis, J.S. (2004). The New Injury Severity Score: A more accurate predictor of in-hospital mortality than the Injury

Severity Score. *The Journal of Trauma: Injury, Infection, and Critical Care, 56*, 1312-1320.

Lee, R.T., & Ashforth, B.E. (1996). A meta-analytic examination of the correlates of the three dimensions of job burnout. *Journal of Applied Psychology, 81,* 123-133.

MacKenzie, E.J., Shapiro, S., & Smith, R.T. (1987). Factors influencing return to work following hospitalisation for traumatic injury. *American Journal of Public Health, 77*, 329-334.

MacKenzie, E.J., Siegel, J.H., & Shapiro, S. (1988). Functional recovery and medical costs of trauma: an analysis by type and severity of injury. *Journal of Trauma, 28,* 281-297.

Madianos, M.G., Papaghelis, M., Ioannovich, J., & Dafni, R. (2001). Psychiatric disorders in burn patients: A follow-up study. *Psychotherapy and Psychosomatics, 70*, 30-37.

Mason, S., Turpin, G., Woods, D., Wardrope, J., & Rowlands, A. (2006). Risk factors for psychological distress following injury. *British Journal of Clinical Psychology, 45,* 217-230.

Mason, S., Wardrope, J., Turpin, G., & Rowlands, A. (2002). The psychological burden of injury: an 18 month prospective cohort study. *Emergency Medicine, 19,* 400-404.

Mayou, R., & Bryant, B. (2003). Consequences of road traffic accidents for different types of road user. *Injury, 34*, 197-202.

Mayou, R., Bryant, B., Ehlers, A. (2001). Prediction of psychological outcomes one year after a motor vehicle accident. *American Journal of Psychiatry, 158*, 1231-1238.

Mayou, R., Tyndel, S., & Bryant, B. (1997). Long-term outcome of motor vehicle accident injury. *Psychsomatic Medicine, 59*(6), 578-584.

McNally, R.J., & Shin, L.M. (1995). Association of intelligence with severity of posttraumatic stress disorder symptoms in Vietnam combat veterans. *American Journal of Psychiatry, 152*, 936-938.

Michaels, A.J., Michaels, C.E., Zimmerman, M.A., Smith, J.S., Moon, C.H., & Peterson, C. (1999). Posttraumatic stress disorder in injured adults: Etiology by path analysis. *The Journal of Trauma: Injury, Infection, and Critical Care*, *47*(5), 867-877.

National Center for Injury Prevention and Control (2007). *WISQAURS Nonfatal Injury Reports 2007.* Retrieved from: http://webappa.cdc.gov/sasweb/ncipc/nfirates2001.html.

Norris, H.H. (1992). Epidemiology of trauma: frequency and impact of different potentially traumatic events on different demographic groups. *Journal of Consulting and Clinical Psychology, 60*, 409-418.

Norton, P.J. (2006). Toward a clinically-oriented model of anxiety disorders. *Cognitive Behaviour Therapy, 35*(2), 88-105.

Norton, P.J. (2008). An open trial of a transdiagnostic cognitive-behavioral group therapy for anxiety disorder. *Behaviour Therapy, 39*, 242-250.

Norton, P.J., & Philipp, L.M. (2008). Transdiagnostic approaches to the treatment of anxiety disorders: A quantitative review. *Psychotherapy Theory, Research, Practice, Training, 45(*2), 214-226.

O'Donnell, M.L., Creamer, M., Bryant, R.A., Schnyder, U., & Shalev, A. (2003). Posttraumatic disorders following injury: An empirical and methodological review. *Clinical Psychology Review, 23,* 587-604.

O'Donnell, M.L., Creamer, M., Elliot, P., Bryant, R., McFarlane, A., & Silove, D. (2009). Prior trauma and psychiatric history as risk factors for intentional and unintentional injury in Australia. *The Journal of Trauma: Injury, Infection, and Critical Care,* 66, 470-476.

O'Donnell M.L., Creamer, M.C., McFarlane, A.C., Silove, D., & Bryant, R.A. (2010). Does access to compensation have an impact on recovery outcomes after injury? *Medical Journal of Australia (MJA),* 192(6), 328-333.

O'Donnell, M.L., Creamer, M., Parslow, R., Elliot, P., Holmes, A.C.N., Ellen, S., & Bryant, R.A. (2008). A predictive screening index for posttraumatic stress disorder and depression following traumatic injury. *Journal of Consulting and Clinical Psychology, 76*(6), 923-932.

O'Donnell, M.L., Creamer, M., Pattison, P. (2004). Posttraumatic stress disorder and depression following trauma: Understanding comorbidity. *American Journal of Psychiatry, 161,* 1390-1396.

O'Donnell, M.L., Creamer, M., Pattison, P., & Atkin, C. (2004). Psychiatric morbidity following injury. *American Journal of Psychiatry, 161*(3), 1-9.

Olff, M., Langeland, W., Draijer, N., & Gersons, B.P.R. (2007). Gender differences in posttraumatic disorder. *Psychological Bulletin, 133*(2), 183-204.

Osler T., Baker, S., & Long, W. (1997). A modification of the Injury Severity Score that both improves accuracy and simplifies screening. *The Journal of Trauma: Injury, Infection and Critical Care, 43*(6), *922-926.*

Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). Predictors of post-traumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129*, 52-73.

Perry, S., Difede, J., Musngi, F., Frances, A.J., & Jacobsberg, L. (1992). Predictors of posttraumatic stress disorder after burn injury. *American Journal of Psychiatry, 149*(7), 931-935.

Quale, A.J., & Schanke, A. (2010). Resilience in the face of coping with a severe physical injury: A study of trajectories of adjustment in a rehabilitation setting. *Rehabilitation Psychology, 55*(1), 12-22.

Quale, A.J., Schanke, A., Froslie, A.F., & Roise, O. (2009). Severity of injury does not have any impact on posttraumatic stress symptoms in severely injured patients. *Injury, 40*, 498-505.

Read, K.M., Kufera, J.A., Dischinger, P.C., Kerns, T.J., Ho, S.M., Burgess, A.R., & Burch, C.A. (2004). Life-altering outcomes after lower extremity injury sustained in motor vehicle crashes. *The Journal of Trauma: Injury, Infection and Critical Care, 57*(4), 815-823.

Resnick, H.S., Yehuda, R., Pitman, R.K., & Foy, D.W. (1995). Effects of previous trauma on acute plasma cortisol level following rape. *American Journal of Psychiatry, 152*, 1675-1677.

Richmond, T.S., Ruzek, J., Ackerson, T., Wiebe, D.J., Winston, F., & Kassam-Adams, N. (2011). Predicting the future development of depression or PTSD after injury. *General Hospital Psychiatry, 33*, 327-335.

Ringburg, A.N., Polinder, S., van Ierland, C.P., Steyerberg, E.W., van Lieshout, E.M., Patka, P., & Schipper, I.B. (2011). Prevalence and prognostic factors of disability after major trauma. *The Journal of Trauma, 70*(4), 916-922.

Schafer, J., & Graham, J. (2002). Missing data: our view of the state of the art. *Psychological Methods*, *7*, 147-177.

Schnyder, U., Moergeli, H., Klaghofer, R., & Buddeberg, C. (2001). Incidence and prediction of posttraumatic stress disorder symptoms in severely injured accident victims. *American Journal of Psychiatry, 158*, 594-599.

Shalev, A.Y., Peri, T., Canetti, L., & Schreiber, S. (1996). Predictors of PTSD in injured trauma survivors: a prospective study. *American Journal of Psychiatry, 153*, 219-225.

Sheehan, D.V., Lecrubier, Y., Harnett-Sheehan, K. Et al. (1998). The Mini International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview. *Journal of Clinical Psychiatry, 5999*(suppl 20), 22-23.

Silva, R.R., Alpert, M. Munoz, D.M., Singh, S., Matzner, F., & Dummit, S. (2000). Stress and vulnerability to posttraumatic stress disorder in children and adolescents. *American Journal of Psychiatry, 157*, 1229-1235.

Simms, L.J., Watson, D., & Doebbeling, B.N. (2002). Confirmatory factor analyses of posttraumatic stress symptoms in deployed and nondeployed veterans of the Gulf War. *Journal of Abnormal Psychology, 111*(4), 637-647.

Singer, J. (1998). Using SAS Proc Mixed to fit multilevel models, hierarchical models and individual growth models. *Journal of Educational and Behavioural Statistics, 24,* 323-355.

Sinharay, S., Stern, H.S., & Russell, D. (2001).The use of multiple imputation for the analysis of missing data. *Psychological Methods, 6*(4), 317-329.

Slade, T., & Watson, D. (2006). The structure of common DSM-IV and ICD-10 mental disorders in the Australian general population. *Psychological Medicine, 36,* 1593-1600.

Sorberg, H.L., Bautz-Holter, E., Roise, O., & Finset, A. (2010). Mental health and posttraumatic stress symptoms 2 years after severe multiple trauma: self-reported disability and psychosocial functioning. *Archives of Physical and Medical Rehabilitation, 91,* 481-488.

Starr, A.J., Smith, W.R., Borer, D.S., Morgan, S.J., Reinert, C.M., Mendoza-Welch, M. (2004). Symptoms of posttraumatic stress disorder after orthopaedic trauma. *The Journal of Bone and Joint Surgery, 86-A*(6), 1115-1121.

Steel, J.L., Dunlavy, A.C., Stillman, J., & Paper, H.C. (2011). Measuring depression and PTSD after trauma: common scales and checklists. *Injury, 42*(3), 288-300.

Van Dijk, K.R., Van Gerven, P.M., Van Boxtel, M.P., Van der Elst, W., & Jolles, J. (2008). No protective effects of education during normal cognitive ageing: results from the 6-year follow-up of the Maastricht Aging Study. *Psychology and Aging, 23*(1), 119-130.

Varney, N.R., Martzke, J., Roberts, R.J. (1987). Major depression in patients with closed head injury. *Neuropsychology, 1,* 7-9.

Vles, W.J., Steyerberg, E.W., Essink-Bot, M-L., van Beeck, E.F., Meeuwis, J.D., & Leenen, L.P.H. (2005). Prevalence and determinants of disabilities and return to work after major trauma. *The Journal of Trauma, 58*(1), 126-135.

Vrana, A., & Lauterbach, D. (1994). Prevalence of traumatic events and posttraumatic psychological symptoms in a non-clinical sample of college students. *Journal of Traumatic Stress,7,* 289-302.

Vodermeir, A., & Millman, R.D. (2011). Accuracy of the Hospital Anxiety and Depression Scale as a screening tool in cancer patients: a systematic review and meta-analysis. *Supportive Care in Cancer, 19*(12), 1899-1908.

Wang, C-H., Tsay, S-L., & Bond, A.E. (2005). Posttraumatic stress disorder, depression, anxiety and quality of life in patients with traffic-related injuries. *Journal of Advanced Nursing, 52*(1), 22-30.

Watson, D. (2009). Differentiating the Mood and Anxiety Disorders: A quadripartite model. *Annual Review of Clinical Psychology, 5,* 221-247.

Weathers, F.W., Keane, T.M., & Davidson, J. (2001). Clinician-administered PTSD scale: A review of the first ten years of research. *Depression and Anxiety, 13*(3), 132-156.

Weaver, T.L., Walter, K.H., Chard, K.M., & Bosch, J. (2014a). Residual injury, appearance-related concerns, symptoms of post-traumatic stress disorder, and depression within a treatment-seeking veteran sample. *Military Medicine, 179,* 1067-1071.

Weaver, T.L., Turner, P.K., Schwarze, N., Thayer, C.A., & Carter-Sand, S. (2007). An exploratory examination of the meanings of residual injuries from intimate partner violence. *Women and Health, 45,* 85-102.

Weaver, T.L., Griffin, M.G., & Mitchell, E.R. (2014b). Symptoms of posttraumatic stress, depression, and body image distress in female victims of physical and sexual assault: exploring integrated responses. *Health Care for Women International, 35,* 458-475.

Wilamowska, Z.A., Thompson-Hollands, J., Fairholme, C.P., Ellard, K.K., Farchione, T.J., & Barlow, D.H. (2010). Conceptual background, development, and preliminary data from the unified protocol for transdiagnostic treatment of emotional disorders. *Depression and Anxiety, 27,* 882-890.

Wiseman, T., Foster, K., & Curtis, K. (2013). Mental health following traumatic physical injury: An integrative literature review. *Injury, 44,* 1393-1390.

World Health Organisation (2002). *The world health report 2002: reducing risks, promoting healthy life.* Geneva, Switzerland.

Yufik, T., & Simms, L.J. (2010). A meta-analytic investigation of the structure of posttraumatic stress disorder symptoms. *Journal of Abnormal Psychology, 119*(4), 764-776.

Zatzick, D.F., Jurkovich, G.J., Gentilello, L., Wisner, D., & Rivara, F.P. (2002). Posttraumatic stress, problem drinking and functional outcomes after injury. *Archives of Surgery, 137,* 200-205.

Zatzick, D.F., Kang, S., Muller, H., Russo, J.E., Rivara, F.P., Katon, W.,, &Roy-Burne, P. (2002). Predicting posttraumatic distress in hospitalised trauma survivors with acute injuries. *American Journal of Psychiatry, 159,* 941-946.

Zatzick, P., Roy-Burne, P., Russo, J., Rivara, F., Droesch, R., & Wagner, A. (2004). A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Archives of General Psychiatry*, *61*(5), 498-506.

Zigmond, A., & Snaith, R. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavia*, *67*, 361-370.

Chapter Four. General Discussion and Conclusions

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4.1 Summary of Thesis Aims and Current Findings

The objective of this program of research was to investigate the mental health outcomes of traumatic physical injury. Two empirical studies were therefore conducted. The aim of the first study was to evaluate and compare the longitudinal trajectory patterns of anxiety, depression and posttraumatic stress disorder (PTSD) symptoms following traumatic injury. The aim of the second study was to investigate the influence of the site and severity of injury respectively, on depression, anxiety and PTSD symptom severity in the initial 12 months following injury.

Given that prior research has consistently associated traumatic injury with poor mental health outcomes (Bryant, 2011; Cameron, Purdie, Kliewer, & McCure, 2006), it was anticipated that this association would be replicated in the first study. In contrast, the available literature regarding specific and comparative trajectories of mental health has been limited to date. Studies broadly exploring the individual trajectories for depression, anxiety and PTSD have identified four typical trajectories that are frequently exhibited for each mental health outcome after injury (Bonanno & Field 2001; Bonanno & Mancini, 2012; deRoon-Cassini, Mancini, Rusch, & Bonanno, 2010; O'Donnell et al., 2004; Quale & Schanke, 2010). These include resilience, recovery, delayed onset, and chronic trajectory. Although these four trajectories have been investigated for each of depression, anxiety and PTSD symptoms, no published studies to date have compared the differences between longitudinal trajectories of these three mental health outcomes. An understanding of the trajectory patterns within the traumatically injured population could facilitate the development of more targeted intervention programs.

The findings from the first study revealed that a delayed onset trajectory was evident for anxiety; whereas a recovery pattern was demonstrated for both PTSD and depression. However, the rate of change over the initial 12-month interval was significantly different between PTSD and depression. Further, in line with previous studies (Holbrook et al., 2003; Ozer, Best, Lipsey, & Weiss, 2003; Steel, Dunlavy, Stillman, & Paper, 2011), as predicted, psychiatric history was significantly related to more severe levels across all three mental health outcomes. Younger age and female gender was also associated with elevated anxiety and PTSD symptoms, when compared to older participants and/or males.

Noting the observed trajectories and the main effect results of sociodemographic associations, it was anticipated that age, gender and the presence of psychiatric history would not impact the established trajectories of anxiety, depression and PTSD symptomatology. This hypothesis was supported by results which indicted that neither age, gender nor the presence of psychiatric history altered the delayed-onset trajectory for anxiety; or the Recovery trajectory that emerged for both PTSD and depression.

Results from the second study provided support for the first hypothesis which had predicted that objective injury severity would be associated with PTSD but not anxiety or depression. Findings indicated that participants with more severe injury reported higher PTSD symptom severity over time compared to participants with a less severe injury. This pattern was not replicated with anxiety or depression, indicating that objective injury severity as measured by the Injury Severity Score (ISS) is not a consistent predictor of the severity or type of mental health outcomes after injury.

The second hypothesis (that is, that body sites that are more visible or evident to the general public would be associated with depression and PTSD) was largely

supported. Results did not demonstrate consistent relationships between individual injury sites and the three mental health outcomes. However, head, face, and external injury were associated with more severe levels of PTSD symptomatology than those reported in participants without injuries in those respective sites. Facial injury was also associated with more severe levels of PTSD symptoms across the 12 months following injury, compared with individuals without a facial injury. Participants with external and lower extremity injuries reported greater depression than participants without these injuries; and participants with lower extremity injury also reported more severe levels of anxiety. Indeed, the aforementioned body sites were conceptualised as being more visible or evident, thus the hypothesis was largely supported.

The third hypothesis was also partially supported as the presence of an injury (in any location) was associated with worse mental health outcomes. Specifically, the presence of a head injury was associated with more severe levels of PTSD symptoms than the absence of head injury; the presence of lower extremity injury was associated with higher levels of depression and anxiety than having no extremity injury; and the presence of external injury was associated with worse depression and PTSD symptomatology.

4.2 The Current Findings Presented within the Traumatic Injury Literature

The impact of traumatic injury has become increasingly important as the full extent of its global and economic burden is evident (Krug, Sharma, & Lozano, 2000; Wiseman, Foster, & Curtis, 2013; Zatzick et al., 2004). Notably, traumatic injury has shown a bi-directional association between physical health and mental health problems (Cameron et al., 2006), with emerging research continuing to demonstrate reduced psychological functioning in individuals following traumatic injury (Sorberg, Bautz-

Holter, Roise, & Finset, 2010; Woolrich, Kennedy, & Tasiemski, 2006), including a heightened risk of PTSD, anxiety and depression (Bryant, 2011). Whilst these mental health outcomes have been regularly associated with traumatic injury through prevalence studies, specific predictors regarding the pathways to each outcome and their longitudinal patterns had yet to be delineated. Research has identified some pre-injury, peri-injury and post-injury features of the individual and environment that are noted as risk factors for worse mental health following exposure to traumatic injury (Doron-La Marca, Vogt, Saxe, King, & King, 2010, Sareen et al., 2013). These include (but are not limited to) pre-injury functioning, younger age, female gender, pre-injury exposure to stressful life events, mechanism of injury (interpersonal, intentional or random), quality and availability of social support, additional life stressors, and internalising or externalising distress coping (Ozer et al., 2003, Sareen et al., 2013). However to date, there is a notable paucity of research which has examined the impact of specific injury-characteristics, including site and severity of injury on PTSD, anxiety and depressive symptom severity. Furthermore, research has shown that there are multiple ways individuals may respond following exposure to potentially traumatic events (inclusive of injury), resulting in four regularly identified prototypical trajectory responses (Bonanno, 2004). However, the individual trajectories of depression, anxiety and PTSD following traumatic injury have yet to be identified or compared within one single study; resulting in an absence of information that could potentially inform clinical practice with regards to the development of targeted treatment for individual symptom profiles, as well as broader conceptual and theoretical research of the differences and similarities between the symptom profiles. Given the high prevalence of mental health problems following from injury, it would be beneficial for clinicians and researchers to be able to identify the injury-related risk factors and likely

trajectories for types of mental health symptom clusters, in order to develop appropriate screening measures and implement early intervention treatment. Taking these steps will allow improvements to the individual's quality of life and overall (mental) health, and potentially assist in mitigating both the micro- and macro-economic burden of injury.

Previous literature has identified resilience as the most common trajectory exhibited after traumatic injury (Bonanno, 2012; de-Roon Cassini et al., 2010; Quale & Schanke, 2010), however the current results are contrary to this pattern. This was not unexpected given the design, research question and methodological differences between the current and prior studies which have typically examined within-outcome trajectories using LGMM analyses. The delayed-onset trajectory exhibited by anxiety may be reflective of an overall pattern of behavioural avoidance triggered initially by cue exposure, and maintained by generalisation of distress intolerance (Barlow, Allen, & Choate, 2004), leading to a linear increase in symptomatology (Barlow, 2014). The recovery trajectories demonstrated by both PTSD and depression suggest that a reduction of symptomatology occurs three months after injury. Whilst this pattern for depression could be reflective of an acute grief or processing phase, it may also be reflective of secondary changes from physical rehabilitation leading to improvements in functional capacity (Holtslag, Post, Lindeman, & van der Werken, 2007a); or be reflective of an individual's subjective characteristics (such as pain or coping self-efficacy) or those of the environment (de-Roon Cassini et al., 2011; Ozer et al., 2003). Regardless, the unexpected PTSD trajectory; and the (statistically significant) dissonance between the trajectories of the three outcomes highlights the need for further investigation of, and consideration given to, conceptual and theoretical

underpinnings that may explain the pattern of results. Indeed, these results were in contention with one of the more widely applied conceptualisations, the transdiagnostic approach, which suggests that all three mental health outcomes load onto one higher order non-specific construct (Cox, Clara, & Enns, 2002). However, despite the fact that the current results do not synthesise with this theory, the potential influence of comorbidity must be considered. Given that comorbidity was not a variable in the current study, it would be of interest to conduct another similar investigation but inclusive of comorbid outcomes, prior to comprehensively discounting an alignment with the transdiagnostic framework.

Consistent with prior research on sociodemographic predictors of mental health outcomes post-trauma (Creamer et al., 2001; Doron La-Marca et al., 2010; Quale, Schanke, Froslie, & Roise, 2009; Steel et al., 2011), younger age, female gender and psychiatric history were all significantly associated with worse depression, anxiety and PTSD symptomatology. Additionally, the finding that sociodemographic factors did not alter the observed trajectory patterns lends further support for the contribution of these factors as stable predictors of mental health outcome, and highlights the robustness and independence of the observed trajectory patterns. Again, these findings extend previous literature in the traumatic injury context by taking three known predictors of mental health outcome and establishing their consistent impact in the traumatic injury domain. Interestingly, these same sociodemographic factors did not show a stable or consistent association with each mental health outcome when injury site and severity were included in the modelling. This suggests that the contributions of site, severity and these three demographic factors to each of PTSD, depression and anxiety are unique, and subsequently warrant further investigation into the mediating

effects of these predictors on each other, as well as on mental health outcomes following injury.

Overall, in line with previous research, there were no consistent relationships between individual sites of injury and all three of depression, anxiety and PTSD symptom severity (Fukunishi, 1999; Holtslag et al., 2007a; Holtslag, van Beeck, Lindeman, & Leenan 2007b). However, for some sites, distinct patterns emerged. As aforementioned, head, facial and external injury were associated with worse PTSD outcome (Fukunishi, 1999; Glynn, Shetty, & Dent, 2010; Haagsma et al., 2012; Madianos, Papaghelis, Ioannovich, & Dafni, 2001), external and lower extremity injury were associated with worse depression symptomatology; and lower extremity injury was also associated with anxiety symptomatology (Holtslag et al., 2007a; Holtslag et al., 2007b). It may be the case that the relationships of head, face external and external injury with PTSD are mediated by disfigurement and body image distress, which has shown a regular association in the literature with PTSD (Fukunishi 1999, Haagsma et al., 2012, Weaver et al., 2014a, Weaver at al., 2014b, Weaver et al., 2007); whereas lower extremity injury may be more associated with functional outcome (Holtslag et al., 2007b).

The inconsistent pattern of results between the current study and previous literature is also likely reflective of methodological differences, whereas previous research has focused on single-site and/or single-outcomes (Fukunishi, 1999; Holtslag et al., 2007a; Holtslag et al., 2007b). But, in the present study, all bodily injury categories were considered in relation to the three mental health outcomes. The current results suggest that whilst the development of mental health symptoms following injury may be affected by an injury in some sites above others, this impact is not uniform and therefore site of injury cannot be considered a sole predictor of mental health outcome

following injury. The inclusion of disfigurement or body image distress in future studies may ameliorate this outcome.

Moreover, consistent with previous research (Bernat, Ronfeldt, Calhoun, & Arias, 1998; Delahanty et al., 2003; Gabert-Quillen, Fallon, & Delahanty, 2011; Koren, Norman, Cohen, Berman, & Klein, 2005), the current findings suggest that the presence of any injury, irrespective of site, is more important in predicting worse mental health symptoms (for each of the three outcomes) than the specific injury site. This finding contributes to the literature by further supporting the exclusion of specific sites as specific predictor variables for all outcomes.

The current findings further revealed that participants with greater objective injury severity reported more elevated PTSD symptom severity within the initial 12-months post-injury than individuals with less severe injuries, irrespective of injury site. Whilst this is in line with some research specifically exploring the association between PTSD and objective injury severity (e.g., Frommberger et al., 1998; Jeavons, 2000), interestingly, this pattern was not replicated with anxiety or depression symptom severity. This means that objective injury severity is not a reliable or consistent predictor for each mental health outcomes; and in this way, extends the current literature base in the context of risk factors precipitated by traumatic injury. It may in fact point to the need for additional consideration to be given to the use of subjective measures of injury severity as predictors of outcome. Previous research has shown that individual characteristics such as cognitive appraisals, subjective measures of pain, and coping self-efficacy (Fulslang, 2000; Gabert-Quillen et al., 2011; O'Donnell, Creamer, Bryant, Schnyder, & Shalev, 2003) may be more reliably predictive of the impact of injury on mental health than objective injury factors (Kreis et al., 2011; Mason, Wardrope, Turpin, & Rowlands, 2006; Quale & Schanke, 2010).

4.3 Implications for Clinical Practice

Given the observable link between the presence of injury and reduced mental health outcomes (inclusive of anxiety, depression and PTSD symptomatology), the current program of research supports the inclusion of physical injury characteristics as vulnerability factors in screening tools to detect mental health problems following traumatic injury. Furthermore, the current project supports the widespread employment of screening tools during the hospitalisation period following injury; and the subsequent implementation of symptom monitoring and/or early intervention where appropriate.

Specifically, the development and use of screening tools (for individuals who have been hospitalised due to traumatic injury) that include the presence of head, face and external injury as well as lower extremity injury and sociodemographic factors (younger age, female gender and the presence of a psychiatric history) as risk factors will allow for a more accurate identification of individuals who are at a greater risk for the subsequent development of mental health problems. In contrast, the inclusion of objective injury severity (as computed by the ISS or other measures) as a sole predictive factor is cautioned against, as current results suggest that it does not provide consistent or reliable predictive information on longitudinal mental health outcomes.

Whilst the identification of symptomatology of the three mental health disorders will be able to guide the appropriateness and direction of treatment, of particular importance during this screening process (or throughout later symptom monitoring) is the early identification of anxiety symptomatology. The nature of its observed delayed onset trajectory suggests that early intervention is essential in mitigating the chronicity of impact on an individual's psychological wellbeing, and

ultimately enabling the best chance of recovery (Barlow, 2014; O'Donnell et al., 2012). Furthermore, although PTSD exhibited a recovery pathway, when site and severity of injury were tested in the model, PTSD emerged as a notable outcome. It might be the case that, as PTSD symptoms reduce, the residual symptoms (which are consistent with anxiety symptomatology) remain, potentially elevating our measurement of anxiety levels and therefore possible amplifying the delayed onset trajectory levels. The inclusion of comorbid outcomes in future research could clarify this relationship.

4.4 Strengths and Limitation of the Current Research

The current program of research both supports and extends previous literature by illustrating a comparison of individual longitudinal trajectories of depression, anxiety and PTSD symptomatology following traumatic injury in a single study. Furthermore, this is the first study conducted using a large-scale prospective longitudinal design with a heterogeneous population of individuals with a wide range of injury severities across a number of sites of injury, measuring three different mental health outcomes. In this way, the program of research contributes to the literature on the role of site and severity of injury as predictors of PTSD symptomatology, depression and anxiety following traumatic injury.

However, the current research is limited by its use of mixed measures between outcomes; specifically the use of a self-report measures for anxiety and depression, and a clinical interview to assess PTSD symptomatology. It is also difficult to infer the impact of additional intrapersonal covariates, such as disfigurement, coping self-efficacy or functional impact (de-Roon Cassini et al., 2011), which might be clinically and theoretically useful in identifying causal relationships between predictors and outcomes. Finally, the inclusion of comorbid outcomes was beyond the scope of the

current study, thus making it difficult to capture a broader picture of the relationships between depression, anxiety and PTSD symptomatology following injury.

4.5 Suggestions for Future Research

Future studies with a continued focus on the predictive characteristics of, and trajectories for, mental health outcomes within the traumatically injured population are warranted. Researchers could combine different statistical approaches to test both a comparison of overall trajectories between depression, anxiety and PTSD. This would extend current knowledge of the underlying individual symptom profile of depression, anxiety and PTSD; and might enhance the conceptual understanding and clinical treatment implications for each outcome. It would also be useful to assess and compare additional mental health outcomes. Of particular relevancy given its trajectory, investigations should include sub-types of anxiety that have also been associated with traumatic injury, including travel anxiety, generalised anxiety disorder (GAD), and panic disorder (Bryant et al., 2010).

It would also be beneficial for future research to evaluate comorbidity, both longitudinally and at specific time points, to more accurately gauge the extent of mental health impacts (O'Donnell et al., 2012). This knowledge could further ascertain either an alignment with, or exclusion of, traumatic injury within a transdiagnostic framework (Barlow et al., 2004; Grant, Beck, Marques, Paylo, & Clapp, 2008).

Additionally, it would be valuable for researchers to investigate the role of subjective covariates including pain, subjective distress, disfigurement, functional

impact and coping self-efficacy on the development and/or trajectories of mental health outcomes following injury. This would be particularly useful given that subjective factors have been correlated with reduced mental health (de-Roon Cassini et al., 2011), but not necessarily assessed within a traumatically injured population.

Finally, future studies addressing some of the methodological limitations of this research project could reinforce and strengthen the current patterns of findings. These areas of improvement could include the standardisation of measurement tools with a preference for clinical interviews for each mental health outcome (Mason, Wardrope, Turpin, & Rowlands, 2002; Weathers, Keane, & Davidson 2001), the use of clinical caseness in the operationalisation of outcomes rather than symptomatology, as well as factoring in comorbidity patterns.

4.6 Conclusions

The results from this current program of research indicate that the trajectories of depression, anxiety and PTSD are each significantly different from each other, despite PTSD and depression symptoms both exhibiting a recovery trajectory. Anxiety was found to have a delayed-onset trajectory; and age, gender, and psychiatric history did not change these trajectory patterns. Furthermore, the results suggest that the presence of injury is more frequently predictive of mental health outcome severity than the objective severity of injury; although objective injury severity is a significant predictor for PTSD symptom severity not for general anxiety and depression symptoms. Finally, head, face, external and lower extremity injuries lead to differential patterns of mental health symptom severity. Consequently, each of these factors warrant further research as they indicate clinical utility, with specific regards to the provision of screening for mental health problems during hospitalisation after traumatic injury.

4.7 References

Barlow, D.H., (Ed.). (2014). *The Oxford Handbook of Clinical Psychology.* UK: Oxford University Press.

Barlow, D.H., Allen, L.B., & Choate, M.L. (2004). Toward a unified treatment for emotional disorders. *Behaviour Therapy, 35,* 205-230.

Bernat, J.A., Ronfeldt, H.M., Calhoun, K.S., & Arias, I. (1998). Prevalence of traumatic events and peritraumatic predictors of posttraumatic stress symptoms in a nonclinical sample of college students. *Journal of Traumatic Stress, 11*(4), 645-664.

Bonanno, G.A. (2004). Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist, 59*(1), 20-28.

Bonanno, G.A., & Field, N.P. (2001). Examining the delayed grief hypothesis across 5 years of bereavement. *American Behavioral Scientist, 44*(5), 798-816.

Bonanno, G.A., Kennedy, P., Galatzer-Levy, I.R., Lude, P., & Elfstrom, M.L. (2012). Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabilitation Psychology, 57*(93), 236-247.

Bonanno, G.A., & Mancini, A.D. (2012). Beyond resilience and PTSD: Mapping the heterogeneity of response to potential trauma. *Psychological Trauma: Theory, Research, Practice & Policy, 4*(1), 74-83.

Bryant, R.A. (2011). Mental disorders and traumatic injury. *Depression and Anxiety, 28,* 99-102.

Bryant, R.A., O'Donnell, M.L., Creamer, M.C., McFarlane, A.C., Clark, C.R., & Silove, D. (2010). The psychiatric sequelae of traumatic injury. *American Journal of Psychiatry, 167*, 312-320.

Cameron, C., Purdie, D.M., Kliewer, E.V., & McClure, R.J. (2006). Mental health: A cause or consequence of injury? A population-based matched cohort study. *BioMed Central Public Health, 6,* 114-123.

Cox, B.J., Clara, I.P., & Enns, M.W. (2002). Posttraumatic stress disorder and the structure of common mental disorders. *Depression and Anxiety, 15*(4), 168-171.

Creamer, M., Burgess, P., & McFarlane, A.C. (2001). Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychological Medicine, 31,* 1237-1247.

Delahanty, D.L., Raimonde, A.J., Spoonster, E., & Cullado, M. (2003). Injury severity, prior trauma history, urinary cortisol levels, and acute PTSD in motor vehicle accident victims. *Journal of Anxiety Disorders, 17*(2), 149-164.

deRoon-Cassini, T.A., Mancini, A.D., Rusch, M.D., & Bonanno, G.A. (2010). Psychopathology and resilience following traumatic injury: A latent growth mixture model analysis. *Rehabilitation Psychology, 55*(1), 1-11.

Doron-La Marca, S., Vogt, D.S., Saxe, G.N., King, D.W., & King, L.A. (2010). Pretrauma problems, prior stressor exposure, and gender as predictors of change in posttraumatic stress symptoms among physically injured children and adolescents. *Journal of Consulting and Clinical Psychology, 78*(6), 781-793.

Frommberger, U.H., Stieglitz, R.D., Nyberg, E., Schlickewei, W., Kuner, E., & Berger, M. (1998). Prediction of posttraumatic stress disorder by immediate reactions to trauma: A prospective study in road traffic accident victims. *European Archives of Psychiatry and Clinical Neuroscience, 248*(6), 316-321.

Fukunishi, I. (1999). Relationship of cosmetic disfigurement to the severity of posttraumatic stress disorder in burn injury or digital amputation. *Psychotherapy and Psychosomatics, 68*, 82-86.

Gabert-Quillen, C.A., Fallon, W., & Delahanty, D.L. (2011). PTSD after traumatic injury: An investigation of the impact of injury severity and peritraumatic moderators. *Journal of Health Psychology, 16*(4), 678-687.

Glynn, S. M., Shetty, V., & Dent, M. (2010). The long-term psychological sequelae of orofacial injury. *Oral Maxillofacial Surgery Clinical North America, 22*(2), 217-224.

Grant, D.M., Beck, J.G., Marques, L., Palyo, S.A., & Clapp, J.D. (2008). The structure of distress following trauma: posttraumatic stress disorder, major depressive disorder, and generalised anxiety disorder. *Journal of Abnormal Psychology, 17*(3), 662-672.

Haagsma, J.A., Ringburg, A.N., van Lieshout, E.M., van Beeck, E.F., Patka, I.B., & Polinder, S. (2012). Prevalence rate, predictors and long-term course of probably posttraumatic disorder after major trauma: a prospective cohort study. *BioMed Central Psychiatry, 12*, 236-245.

Holbrook, T.L., Hoyt, D.B., & Anderson, J.P. (2001). The impact of major in-hospital complications on functional outcome and quality of life after trauma. *Journal of Trauma, 50*(1), 91-95.

Holbrook, T.L., Hoyt, D.B., Stein, M.B., & Sieber, W.J. (2001). Perceived threat to life predicts posttraumatic stress disorder after major trauma: Risk factors and functional outcome. *The Journal of Trauma: Injury, Infection, and Critical Care, 51*, 287-293.

Holbrook, T.L., Hoyt, D.B., Stein, M.B., & Sieber, W.J. (2002). Gender differences in long-term posttraumatic stress disorder outcomes after major trauma: Women are at higher risk of adverse outcomes than men. *The Journal of Trauma, 53*(5), 882-888.

Holtslag, H.R., Post, M.W., Lindeman, E., & van der Werken, C. (2007). Long-term functional health status of severely injured patients. *Injury, 38,* 280-289.

Holtslag, H.R van Beeck, E.F., Lindeman, E., & Leenan, L.P.H. (2007). Determinants of long-term functional consequences after major trauma. *The Journal of Trauma: Injury, Infection and Critical Care, 62*(4), 919-927.

Jeavons, S. (2000). Predicting who suffers from psychological trauma in the first year after a road accident. *Behaviour Research and Therapy, 38*(5), 499-508.

Koren, D., Norman, D., Cohen, A., Berman, J. & Klein, E.M. (2005). Increased PTSD risk with combat-related injury: A matched comparison study of injured and uninjured soldiers experiencing the same combat events. *American Journal of Psychiatry, 162*(2), 276-282.

Kreis, B.E., Castano, N.J.Y., Tuinebreijer, W.E., Hoogenboom, L.C.A., Meylaerts, S.A.G., & Rhemrev, S.J. (2011). Characteristics of polytrauma patients with posttraumatic stress disorder in a level 1 trauma center. *European Journal of Trauma and Emergency Surgery, 37,* 269-275.

Krug, E., Sharma, G., & Lozano, R. (2000). The global burden of injuries. *American Journal of Public Health, 90,* 523-526.

Madianos, M.G., Papaghelis, M., Ioannovich, J., & Dafni, R. (2001). Psychiatric disorders in burn patients: A follow-up study. *Psychotherapy and Psychosomatics, 70,* 30-37.

Mason, S., Turpin, G., Woods, D., Wardrope, J., & Rowlands, A. (2006). Risk factors for psychological distress following injury. *British Journal of Clinical Psychology, 45,* 217-230.

Mason, S., Wardrope, J., Turpin, G., & Rowlands, A. (2002). The psychological burden of injury: an 18 month prospective cohort study. *Emergency Medicine, 19,* 400-404.

O'Donnell, M.L., Creamer, M., & Pattison, P. (2004a). Posttraumatic stress disorder and depression following trauma: Understanding comorbidity. *American Journal of Psychiatry, 161,* 1390-1396.

O'Donnell, M.L., Creamer, M., Pattison, P., & Atkin, C. (2004b). Psychiatric morbidity following injury. *American Journal of Psychiatry*, *161*(3), 1-9.

O'Donnell. M.L., Lau, W., Tipping, S., Holmes, A.C.N., Ellen, S., Judson, R.,…Forbes, D. (2012). Stepped early psychological intervention for posttraumatic stress disorder, other anxiety disorders, and depression following serious injury. *Journal of Traumatic Stress*, *25*(2), 125-133.

Ozer, E.J., Best, S.R., Lipsey, T.L., & Weiss, D.S. (2003). Predictors of post-traumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129,* 52-73.

Quale, A.J., Schanke, A., Froslie, A.F., & Roise, O. (2009). Severity of injury does not have any impact on posttraumatic stress symptoms in severely injured patients. *Injury, 40*, 498-505.

Quale, A.J., & Schanke, A. (2010). Resilience in the face of coping with a severe physical injury: A study of trajectories of adjustment in a rehabilitation setting. *Rehabilitation Psychology, 55*(1), 12-22.

Sluys, K., Haggmark, T., & Iselius, L. (2005). Outcome and quality of life 5 years after major trauma. *The Journal of Trauma: Injury, Infection and Critical Care, 59*(1), 223-232.

Sorberg, H.L., Bautz-Holter, E., Roise, O., & Finset, A. (2010). Mental health and posttraumatic stress symptoms 2 years after severe multiple trauma: self-reported disability and psychosocial functioning. *Archives of Physical and Medical Rehabilitation, 91*, 481-488.

Steel, J.L., Dunlavy, A.C., Stillman, J., & Paper, H.C. (2011). Measuring depression and PTSD after trauma: common scales and checklists. *Injury, 42*(3), 288-300.

Weathers, F.W., Keane, T.M., & Davidson, J. (2001). Clinician-administered PTSD scale: A review of the first ten years of research. *Depression and Anxiety, 13*(3), 132-156.

White, B., Driver, S., & Warren, A.M. (2008). Considering resilience in the rehabilitation of people with traumatic disabilities. *Rehabilitation Psychology, 53*(1), 90-17.

Wiseman, T., Foster, K., & Curtis, K. (2013). Mental health following traumatic physical injury: An integrative literature review. *Injury, 44*, 1393-1390.

Woolrich, R.A., Kennedy, P., & Tasiemski, T. (2006). A preliminary psychometric evaluation of the Hospital Anxiety and Depression Scale (HADS) in 963 people living with a spinal cord injury. *Psychology, Health & Medicine, 11*(1), 80-90.

Zatzick, P., Roy-Burne, P., Russo, J., Rivara, F., Droesch, R., & Wagner, A. (2004). A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Archives of General Psychiatry, 61*(5), 498-506.

Appendices A - F. Additional Analyses from Chapter Three.

Appendix A

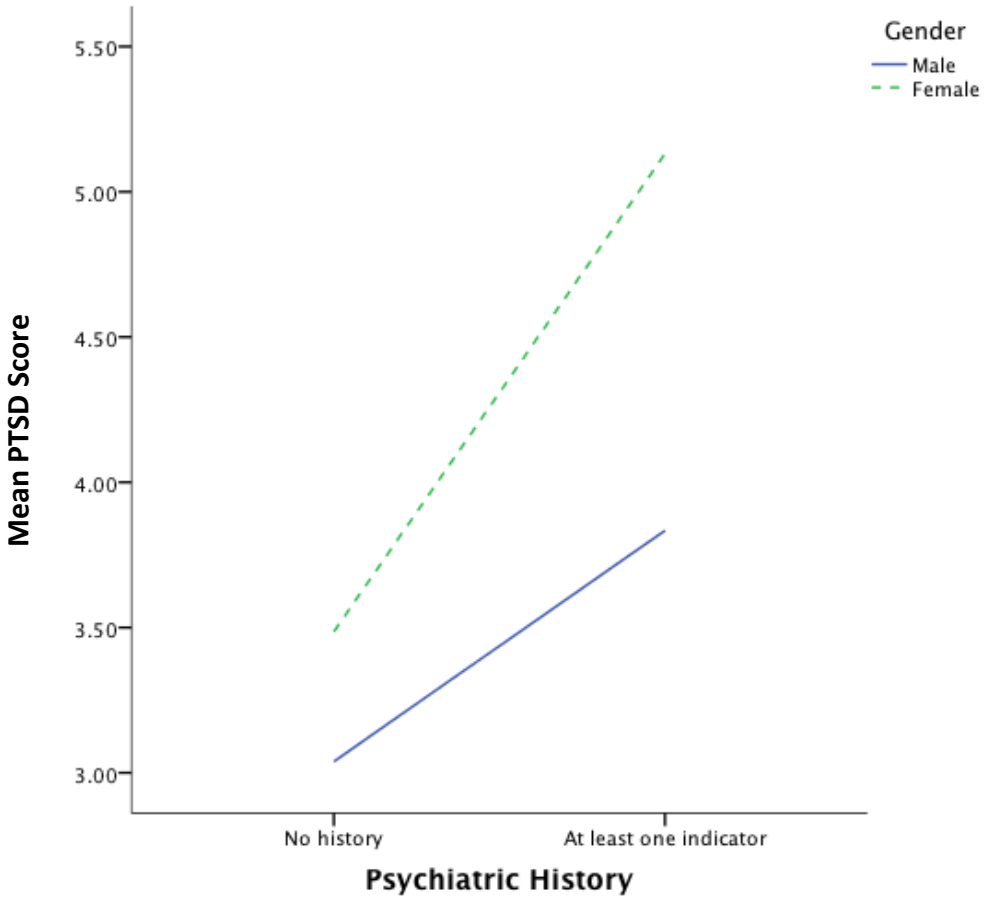

Figure 1A. Significant interaction between age and psychiatric history on PTSD symptom severity.

Appendix B

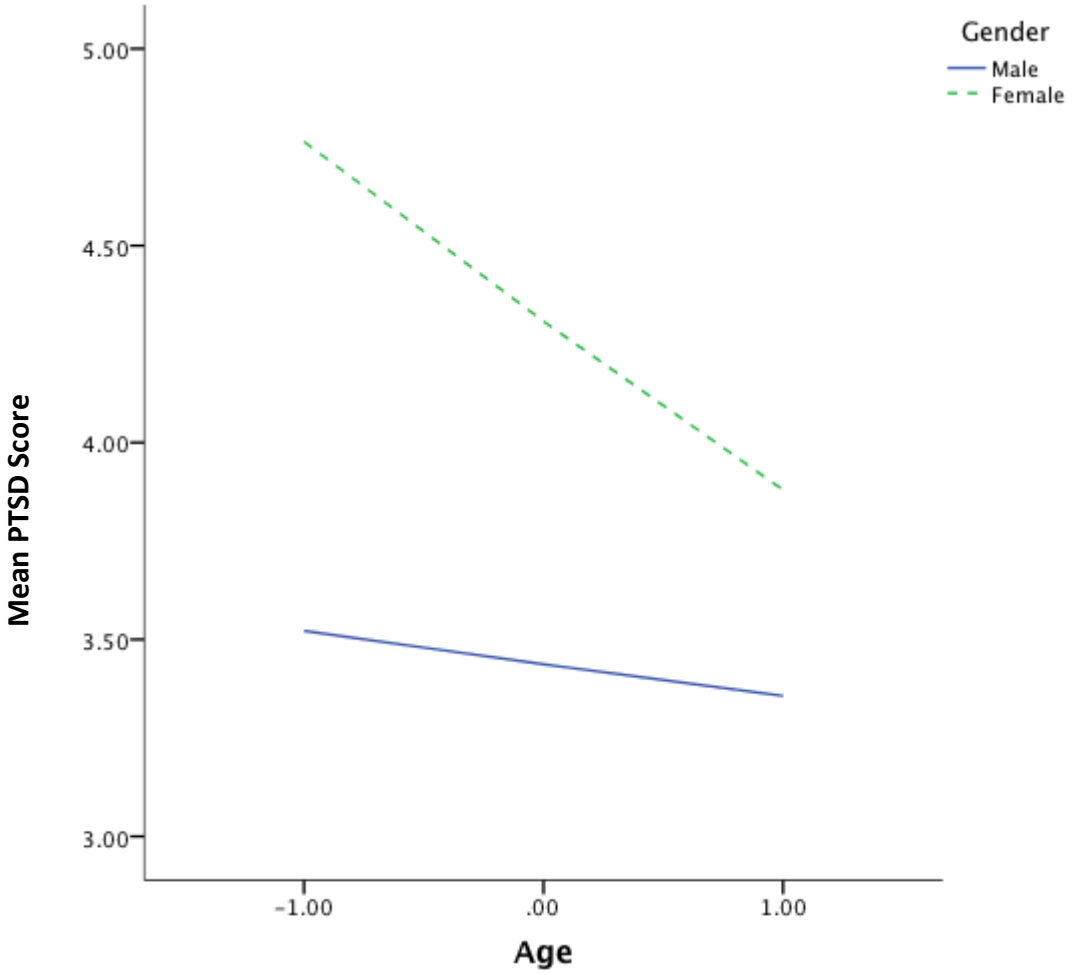

Figure 2A. Significant interaction between age and gender on PTSD symptom severity; '0' = mean of age; '-1' = 1 SD below the mean of age; 1.00 = 1 SD above the mean. Age increases along the X-Axis.

Appendix C

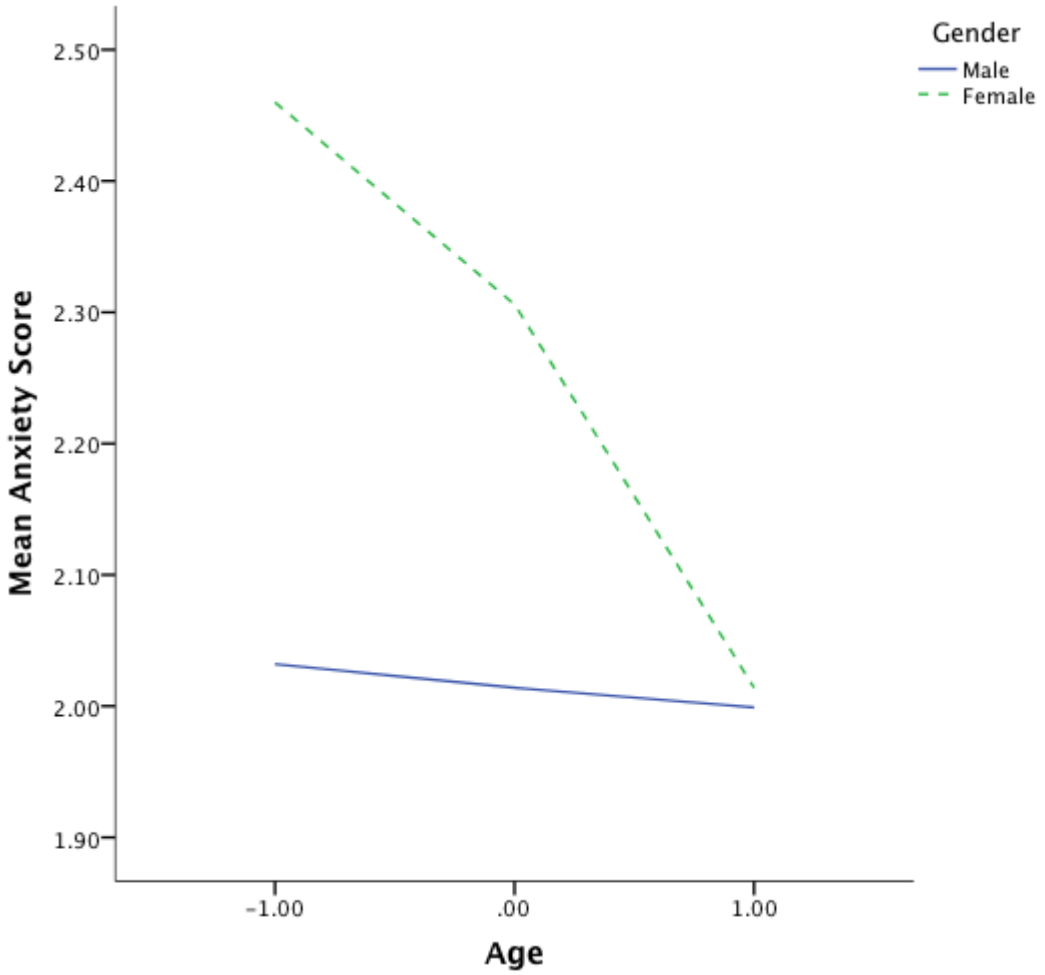

Figure 3A. Significant interaction between age and gender on anxiety. '0' = mean of age; '-1' = 1 SD below the mean of age; 1.00 = 1 SD above the mean. Age increases along the X-Axis.

Appendix D

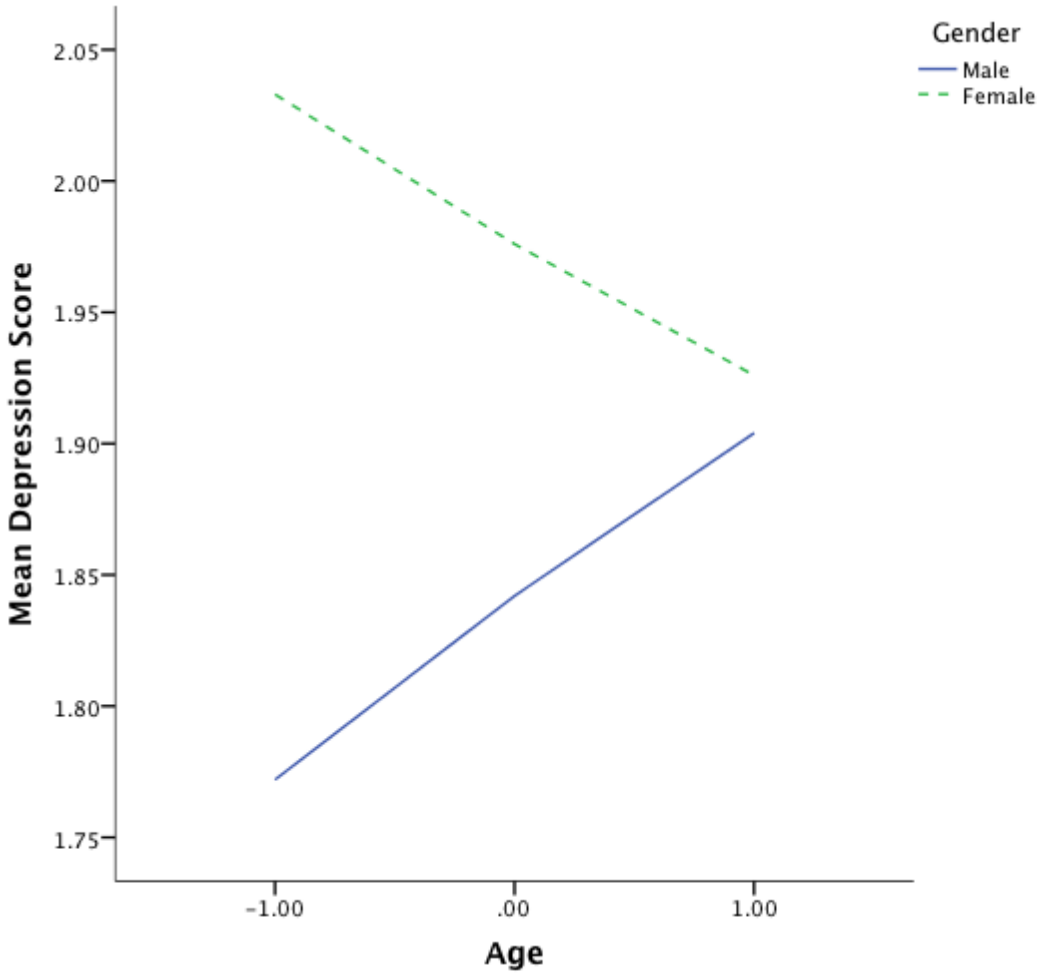

Figure 4A. Significant interaction between age and gender on depression. '0' = mean of age; '-1' = 1 SD below the mean of age; 1.00 = 1 SD above the mean. Age increases along the X-Axis

Appendix E

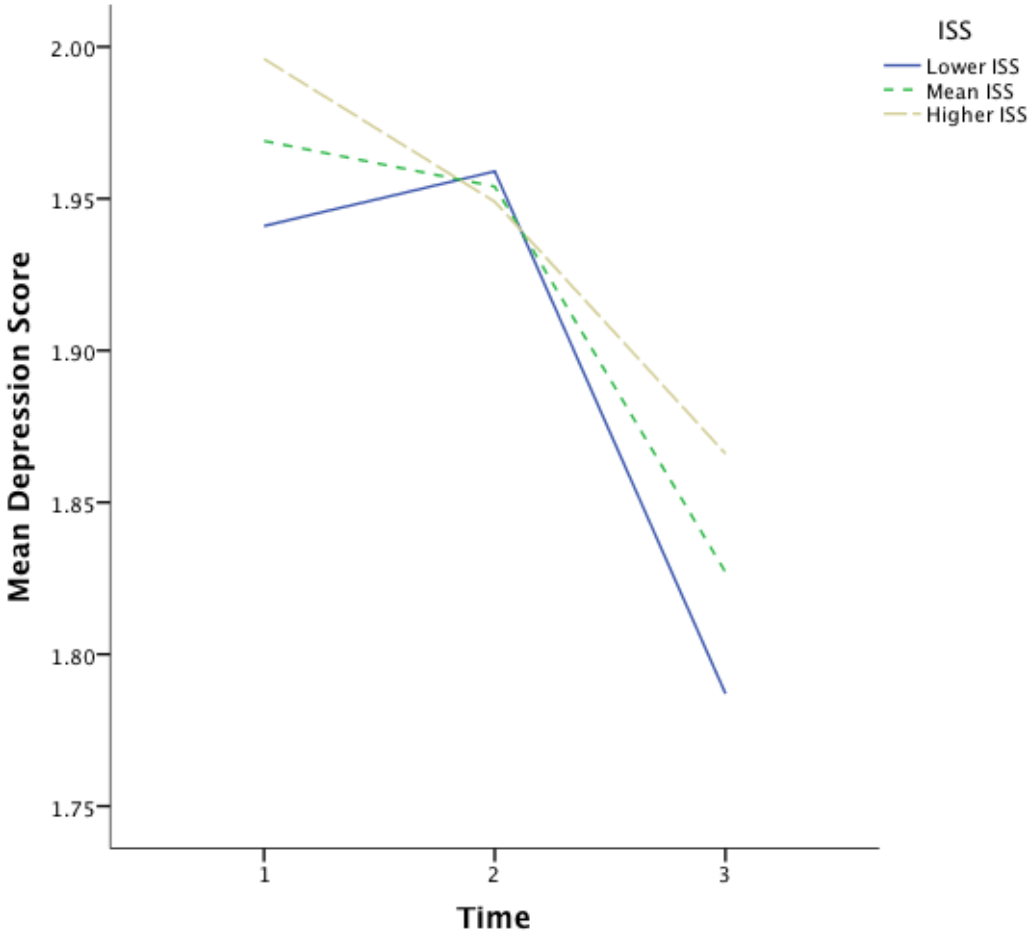

Figure 5A. The non-significant interaction effect of ISS X Time on Depression. 'Mean ISS' = mean of ISS; 'Lower ISS' = 1 SD below the mean of ISS; 'Higher ISS' = 1 SD above the mean.

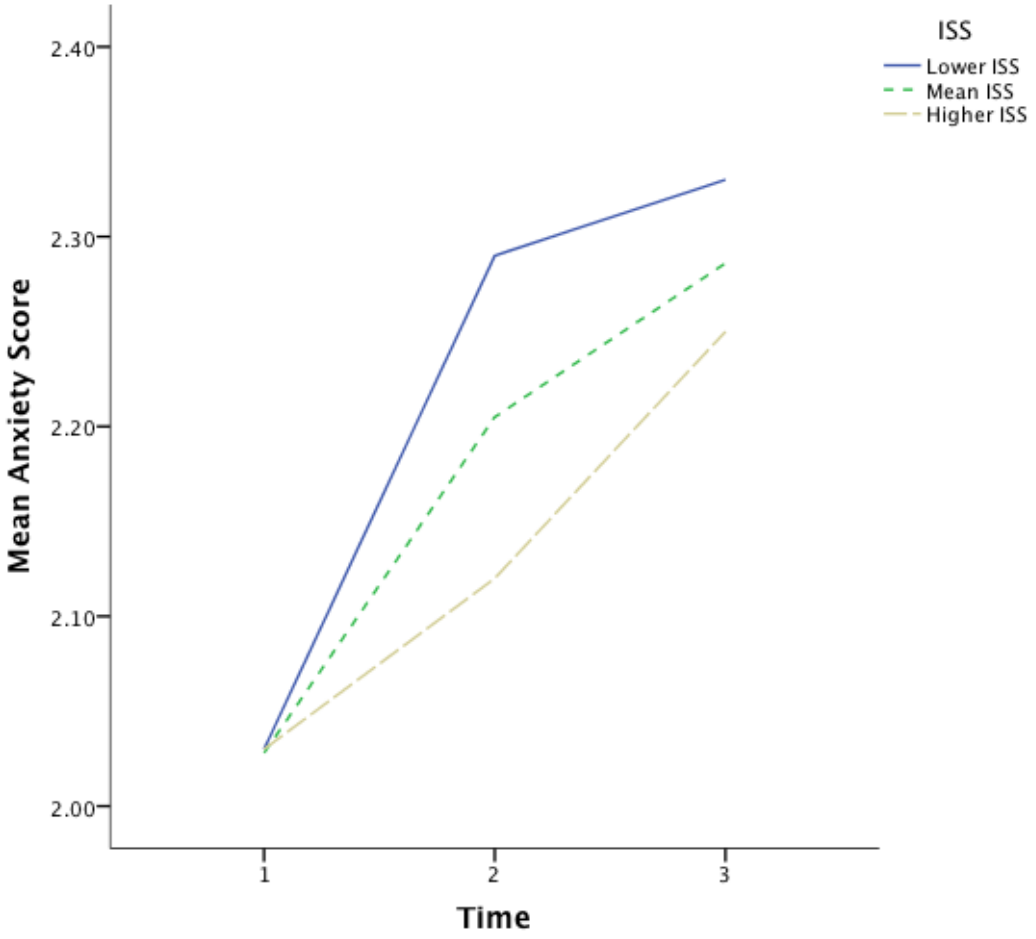

Figure 6A. The non-significant interaction effect of ISS X Time on Anxiety. 'Mean ISS' = mean of ISS; 'Lower ISS' = 1 SD below the mean of ISS; 'Higher ISS' = 1 SD above the mean.

Appendix F

Final model

There were no significant interactions between sociodemographic variables and injury site on any of the mental health outcomes. Results of the Time X Site interaction revealed a significant interaction between thorax and time on depressive symptoms, $F(2, 1650.70) = 3.49$, $p = .03$, such that the rate of recovery differed for individuals with thorax injury than for those without it. Specifically, the presence of thorax injury was found to be associated with less depression over time and a faster recovery, compared to individuals with other types of injury. A significant interaction was also found between facial injury and time on PTSD symptom severity, $F(2, 1769.71) = 3.84$, $p = .02$ (see Figure 7A). Specifically, participants with facial injuries reported significantly higher levels of PTSD symptomatology over time, compared with individuals without facial injury but with other types of injury. Further, although participants with and without facial injury demonstrated an overall similar pattern for PTSD symptom severity, the rates of change in symptom severity between groups were markedly different (see Figure 9A), a finding that is further illustrated in the tests of simple effects (see Table 1A).

Given that the interactions between Time x Site (facial injury) on PTSD symptom severity, and Time x Site (thorax injury) on depression reached significance, tests of simple effects were subsequently conducted on these results. Results revealed a significant effect of Time on depression within the thorax injury category: presence of thorax injury, $F(2, 1654.73) = 5.68$, $p = .00$; and absence of thorax injury, $F(2, 1633.71) = 9.41$, $p = .00$. Pairwise comparisons indicated that participants with a thorax injury reported significantly higher depression scores at Time 1 than at Time 2 (mean difference = 0.23, $SE = 0.09$, $p = .01$); and a significantly higher depression scores at

Time 1 than at Time 3 (mean difference = 0.29, *SE* = 0.09, *p* = .00). A review of the means (see Table 1A) indicated that the reported depression scores of participants with thorax injuries decreased from Time 1 to Time 2, then decreased again from Time 2 to Time 3.

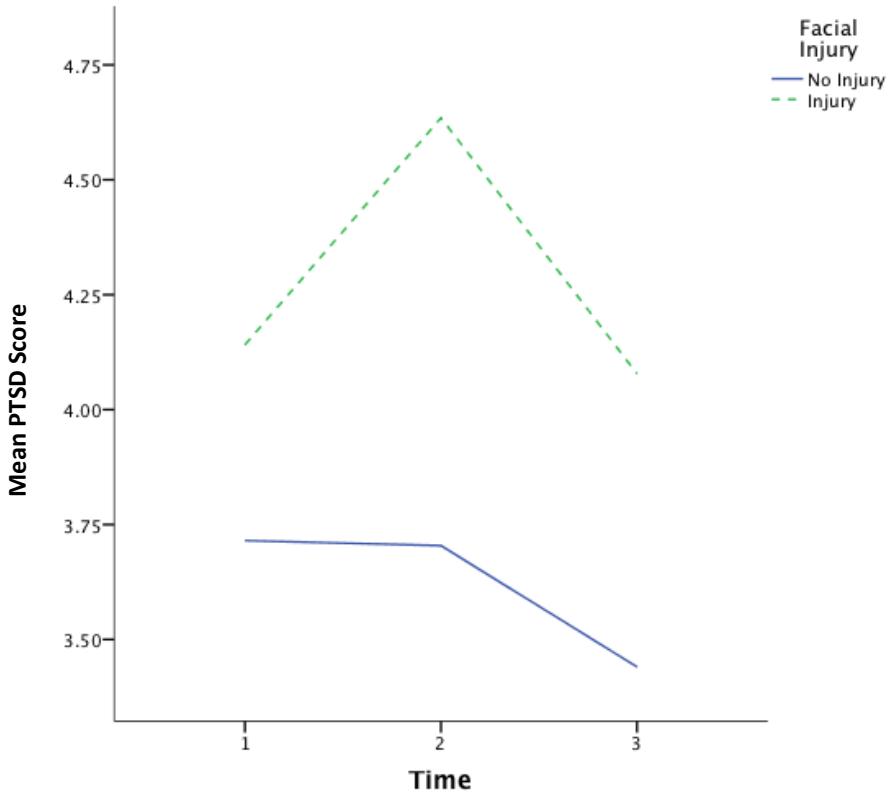

Figure 7A: The significant interaction effect of Time X Site (Face) on Posttraumatic Stress Symptomatology.

Further tests of simple effects revealed a significant effect of thorax injury within Time 2, *F*(1, 2157.97) = 7.38, *p* = .01. Specifically, pairwise comparisons indicated that at Time 2, participants with a thorax injury reported significantly lower depression scores than people without a thorax injury (mean difference = 0.26, *SE* = 0.10, *p* = .01). This unexpected direction of results is contrary to predictions.

Results revealed a significant effect of Time on PTSD symptom severity within the facial injury category: presence of facial injury, $F(2, 1769.05) = 7.23$, $p = .00$; and absence of facial injury, $F(2, 1770.60) = 4.56$, $p = .01$. Pairwise comparisons indicated that participants with a facial injury reported significantly higher PTSD symptom severity scores at Time 2 than at Time 1 (mean difference = 0.49, $SE = 0.15$, $p = .00$); and a significantly higher PTSD symptom severity score at Time 2 than at Time 3 (mean difference = 0.55, $SE = 0.16$, $p = .00$). A review of the means (see Table 1A) indicated that the reported PTSD symptom scores of participants with facial injuries increased from Time 1 to Time 2, then decreased from Time 2 to Time 3, ending scores that were below baseline (Time 1) scores at Time 3.

Further tests of simple effects revealed a significant effect of facial injury within Time 2, $F(1, 1894.78) = 18.39$, $p = .00$, and Time 3, $F(1, 2057.78) = 5.83$, $p = .02$. Specifically, pairwise comparisons indicated that at Time 2 people with a facial injury reported significantly higher PTSD symptom severity than people without a facial injury (mean difference = 0.79, $SE = 0.18$, $p = .00$). Similarly, at Time 3 people with a facial injury reported a significantly higher PTSD symptom severity than people without a facial injury (mean difference = 0.46, $SE = 0.19$, $p = .02$).

Table 1A

Mean Outcome Scores for Significant Interactions between PTSD Symptom Severity Scores with Facial Injury; and Depression with Thorax Injury at Three Time Points

Outcome	Injury Site	Time 1	Time 2	Time 3
PTSD Symptom Score	Facial	4.151	4.646	4.100
Depression	Thorax	2.010	1.787	1.717

Additional random intercept mixed modelling interaction analyses were conducted as part of the final model. These included a Site X Objective Injury Severity (ISS) interaction for each of the three mental health outcomes (depression, anxiety and posttraumatic stress severity). Results revealed a significant interaction effect between objective injury severity (ISS) and neck injury (site) for PTSD symptomatology, such that the pattern of PTSD symptomatology differed between participants with and without neck injury of differing injury severities, $F(1, 1358.37) = 10.75$, $p = .00$. Specifically, and unexpectedly, participants with neck injuries indicated that having a higher ISS was associated with a lower PTSD symptom severity.

A final random intercept mixed modelling interaction analysis was conducted as part of the final model. The Time X Site X ISS interaction revealed a significant result between neck injury and PTSD symptom severity across time, $F(2, 1891.85) = 3.18$, $p = .04$. Specifically, the trajectory of PTSD symptom severity over time differed significantly between participants with and without neck injury of differing injury severities. This extends the previous interaction effect (ISS x Site [neck]) on PTSD symptom severity. Participants who reported a neck injury (irrespective of severity) exhibited a consistent trend in their PTSD symptom severity trajectory over time, reporting an increase in scores from Time 1 to Time 2, followed by a decrease in scores from Time 2 to Time 3. Participants with a more severe neck injury reported a lower PTSD symptom severity score at each time point than participants with a less severe neck injury. This pattern contrasted with participants who did not experience a neck injury. Participants without a neck injury exhibited a higher PTSD symptom severity score than those with a neck injury across all categories. Further, irrespective of severity of injuries, participants without a neck injury indicated a generally consistent

PTSD symptomatology score over time, showing a minor, non-significant increase from Time 1 to Time 2, and a minor non-significant decrease from Time 2 to Time 3.

This unusual pattern of results for neck injury is likely accounted for by the small number of cases of participants who reported a neck injury (n = 10), and the correlations between neck injury and other injuries in the model.

Additionally, both spine and lower extremity injury sites were found to have significant Time X Site X ISS interactions for depression (see Figures 8A and 9A). Results suggest that the severity of injuries had a different impact on the trajectory of depression over time for participants who had spinal injury compared with those that did not have a spinal injury, $F(2, 1638.75) = 3.17$, $p = .04$; and for those that had lower extremity injury compared to those that did not have lower extremity injury, $F(2, 1631.44) = 3.74$, $p = .02$.

Specifically (as illustrated in Figure 8A), participants with a more severe spinal injury exhibited a non-linear increase in depression over time in comparison to participants with a less severe spinal injury, who exhibited a non-linear decrease in depression over time. This pattern contrasted with participants without a spinal injury (but who reported other injuries), whose results suggested that a higher injury severity (as measured by the ISS) followed a non-linear decrease in depression over time; whereas participants with a lower injury severity exhibited an initial decrease, followed by an increase in depression between time points.

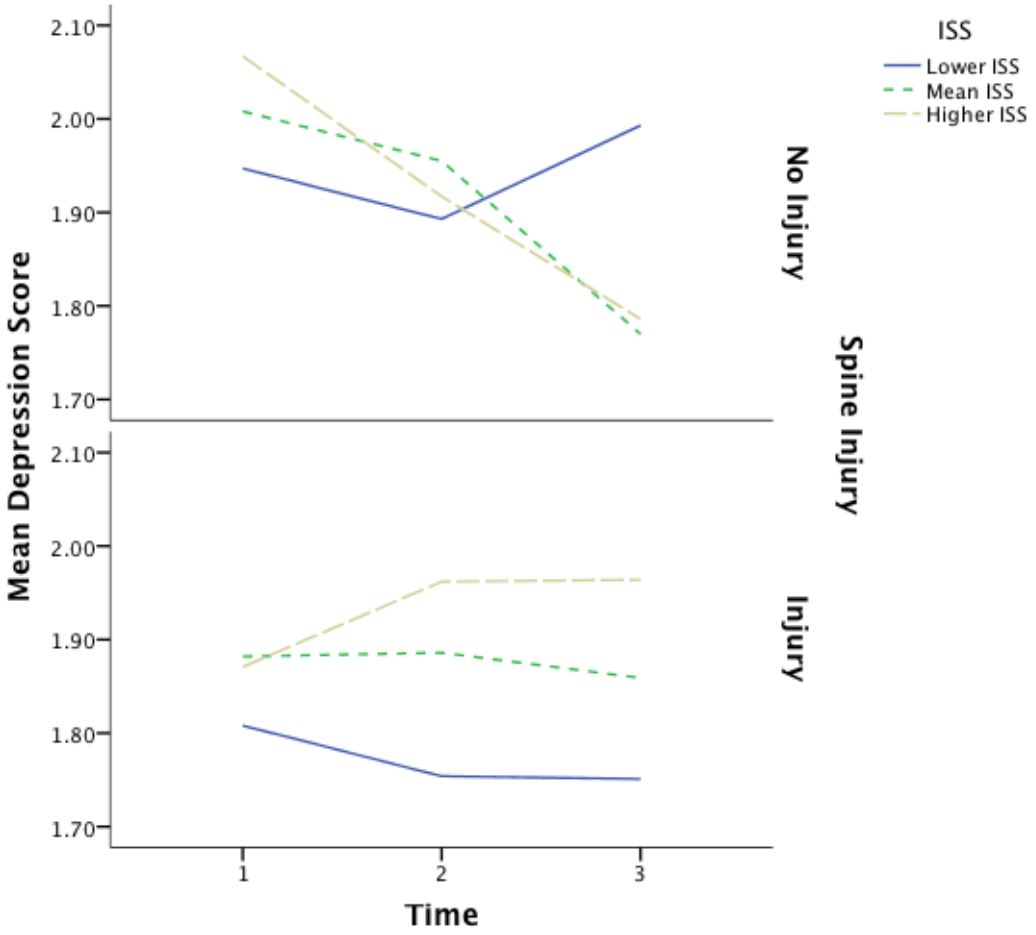

Figure 8A: The significant interaction effect of Time X Site (Spine) X ISS on Depression. ISS = Injury Severity Score; 'Mean ISS' = mean of ISS; 'Lower ISS' = 1 SD below the mean of ISS; 'Higher ISS' = 1 SD above the mean.

Further, participants with a more severe lower extremity injury exhibited a generally stable level of depression across time which, although initially lower than participants with a lower ISS, became higher than the lower severity (ISS) depression group at Time 3 (see Figure 9A). This compared with participants who reported a less severe lower extremity injury and whose depression began at a higher level at Time 1, increased to Time 2, and decreased notably at Time 3. The pattern of results of participants who reported a lower extremity injury differed significantly from

participants who did not report a lower extremity injury (but who reported other injuries), whose results suggested a non-linear decrease in depression irrespective of severity; and higher initial depression for participants who reported a higher ISS.

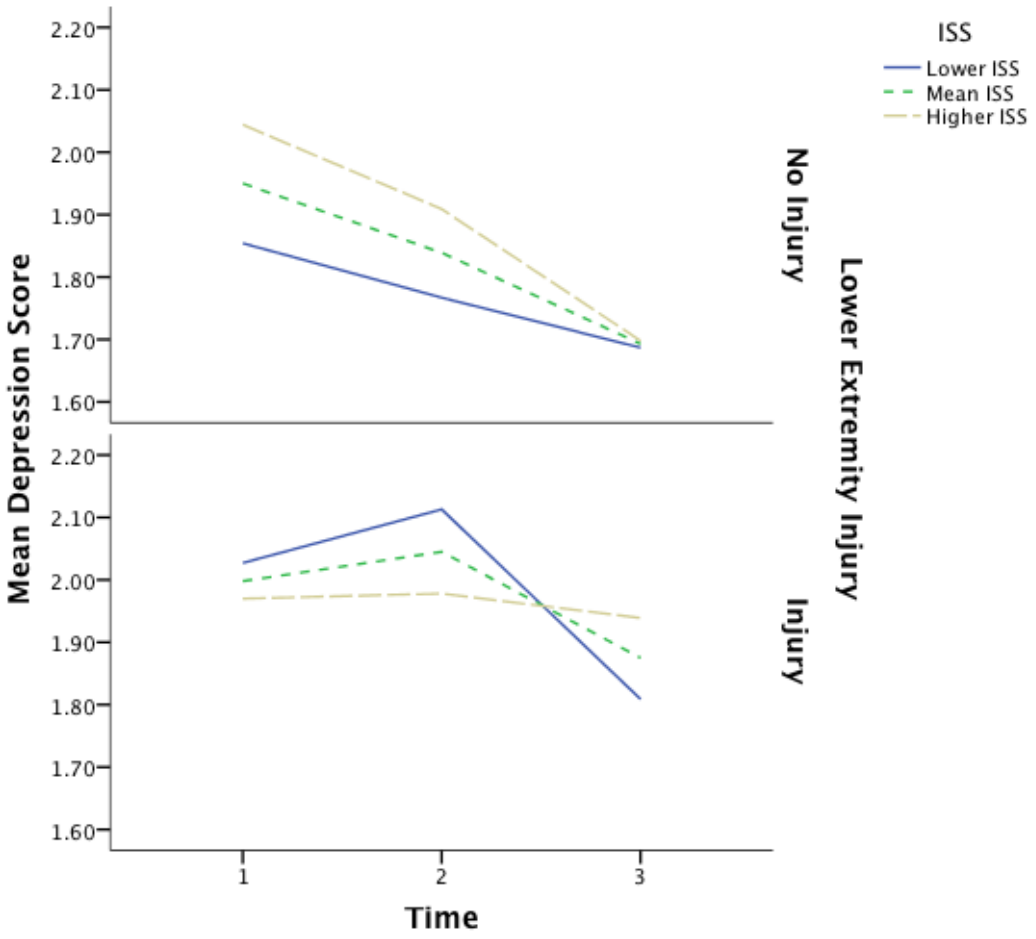

Figure 9A. The significant interaction effect of Time X Site (Lower Extremity) X ISS on Depression. ISS = Injury Severity Score; 'Mean ISS' = mean of ISS; 'Lower ISS' = 1 SD below the mean of ISS; 'Higher ISS' = 1 SD above the mean.

Notwithstanding the above results, there were no further significant outcomes derived from ISS X Site interactions for any of the three mental health outcomes.

Appendix G. Ethics Approval from The University of Melbourne, Australia.

ACPMH

Australian Centre for Posttraumatic Mental Health

Trauma related research, training and policy development

THE UNIVERSITY OF MELBOURNE

Human Research Ethics Office
Melbourne Research and Innovation Office
Level 5, Alan Gilbert Building
161 Barry Street
University Square
The University of Melbourne

16 June 2004

Dear Officer

I wish to register with the University of Melbourne's Human Research Ethics Office a study titled "Psychopathology following traumatic injury: Screening for high risk". I am principal investigator on the study, and am located at the Australian Centre for Posttraumatic Mental Health within the Department of Psychiatry, University of Melbourne. This study is occurring across two hospital sites, the Royal Melbourne Hospital and the Alfred Hospital.

Enclosed are full copies of our ethics applications to Royal Melbourne Hospital and the Alfred Hospital, letters of approval from both hospital ethics committees, and amendment notices with approval.

Should you require further information, do not hesitate to contact me on 9496 2110.

Yours sincerely

Meaghan O'Donnell (PhD)
Senior Research Fellow
ACPMH
National Trauma Research Institute

Australian Centre for Posttraumatic Mental Health Inc.
PO Box 5444 Heidelberg West Victoria 3081 Australia
Tel: +61 3 9496 2922 Fax: +61 3 9496 2830
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Web: www.acpmh.unimelb.edu.au
ABN: 47 720 569 707 ABRN: 095 202 994 REG NO: A0040382V

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THEMIS Ethics

Ethics Record Overview

Ethics ID	Last Date Record Updated	Last Update By	Status	Status Reason	Status Date
040383X	15-Aug-2011	Callahan, Mr Anthony	Active	Continuing	23-Feb-2010

Application Type:	Registration	**Approval Category:**	HESC
Responsible HEAG:	Psychiatry	**HESC:**	Health Sciences
Approval Date:	28-Aug-2003	**Special Conditions of Approval:**	☐
Annual Expiry Date:	31-Dec-2011	**Maximum Expiry Date:**	31-Dec-2011
Administering Department	554 - Psychiatry	**Administering Centre (if applicable)**	

Related Documents

Application Versions

Version Name	System Status	Operational Status	Status Set By	Last Update	Last Updated By	View	Update
040383.1	Finalised	Approved HESC	Jennifer Mary Arnett	15-AUG-2011	Callahan, Mr Anthony		

Annual Reports

Number	Year	System Status	Operational Status	Status Set By	Last Update	Last Updated By	View	Update
1	2006	Finalised	Approved (set at submission)	O'Donnell, Dr Meaghan	30-Apr-2007	O'Donnell, Dr Meaghan		
2	2007	Finalised	Approved (set at submission)	O'Donnell, Dr Meaghan	08-Jan-2008	O'Donnell, Dr Meaghan		
3	2008	Finalised	Approved HESC	Iacovino, Miss Leonarda	28-Apr-2009	O'Donnell, Dr Meaghan		
4	2009	Finalised	Approved HESC	Iacovino, Miss Leonarda	23-Feb-2010	Iacovino, Miss Leonarda		
5	2010	Finalised	Approved HESC	Iacovino, Miss Leonarda	21-Dec-2010	O'Donnell, Dr Meaghan		

Ethics Application ID	Approval Category	Responsible HEAG	HESC	Status
040383.1	HESC	Psychiatry	Health Sciences	Approved HESC

Title: **Psychopathology following traumatic injury: Screening for high risk**
Application Type: **Registration**
Project Type: **Staff Research Project**
Description: **see application**
Proposed duration of the WHOLE research Project: **AUG-2003**To: **DEC-2009**
Proposed Start Date for Data Collection of the project: **28-Aug-2003**

Selected Research Checklist Items

None of the above

Associated Personnel

Name	Role	Type	Department/Organisation
O'Donnell, Dr Meaghan	Responsible Researcher	Staff	554 - Psychiatry
Liedl, Alexandra	Student Researcher	External	Organisation Name not found
Kowitz, Ms Simone	Student Researcher	External	Monash University
Baecher, Kate	Student Researcher	External	Macquarie University
Carty, Ms Jessica	Student Researcher	External	La Trobe University
Holmes, A/Prof Alexander	Co researcher	Staff	554 - Psychiatry
Creamer, Prof Mark	Co researcher	Staff	554 - Psychiatry
Judson, Mr Rodney	Co researcher	Staff	556 - Surgery - Royal Melbourne Hospital

Additional Questions

No additional questions required.

Attached Hard Copy Documents

Attachment Type	Description
No hard copy attachments.	

Attached Electronic Documents

File Name	Type	Description	Category	Last Updated By	Last Updated	Usage	Update	Delete
No results found.								

Appendix H. Ethics Approval from Royal Melbourne Hospital, Australia.

PO Royal Melbourne Hospital
Parkville Victoria 3050
Telephone 61 3 9342 8530
Facsimile 61 3 9342 8548
Email: research.directorate@mh.org.au
Website: www.mh.org.au/research
ABN 73 802 706 972

MELBOURNE HEALTH

RESEARCH DIRECTORATE

12th July 2005

Dr Meaghan O'Donnell
ACPMH
ARMC
PO Box 5444
HEIDELBERG WEST 3081

Dear Meaghan,

Re: MHREC 2003.032 Psychopathology following traumatic injury: Screening for high risk

Thank you for your correspondence requesting approval for amendment to the above protocol.

Your amendments requesting the:

1. *Nesting of a small study within the larger study and the addition of the Cognitive Emotional Regulation Questionnaire, International Personality Item Pool Neuroticism Scale, the Physical Reaction Scale and the Rumination Scale.*
2. *Collection of Cognitive emotional regulation and appraisal at 3 months.*
3. *Addition of the SPHERE questionnaire.*

Were reviewed and approved by the Mental Health Research and Ethics Committee on the 6th July 2005.

The current contract signed by the Chairperson will cover the approval given for the above amendment to proceed.

Yours Sincerely,

DR. STACEY GABRIEL
Secretary
Mental Health Research and Ethics Committee

Appendix I. Ethics Approval from Macquarie University Human Research Ethics Committee

MACQUARIE
University

KATHARINE BAECHER <katherine.baecher@students.mq.edu.au>

External Approval Noted- Kangas (5201100800 D)

Ethics Secretariat <ethics.secretariat@mq.edu.au> Wed, Oct 5, 2011 at 10:21 AM
To: Dr Maria Kangas <maria.kangas@mq.edu.au>
Cc: Ms Katharine Baecher <katharine.baecher@students.mq.edu.au>

Dear Dr Kangas

Re: "Psychopathology following traumatic injury: Screening for high risk"

The above application was considered by the Executive of the Human Research Ethics Committee. In accordance with section 5.5 of the National Statement on Ethical Conduct in Human Research (2007) the Executive noted the final approval from the University of Melbourne and your right to proceed under their authority.

Please do not hesitate to contact the Ethics Secretariat if you have any questions or concerns.

Please do not hesitate to contact the Ethics Secretariat at the address below, if you require a hard copy letter of the above notification.

Please retain a copy of this email as this is your official notification of external approval being noted.

Yours sincerely

Dr Karolyn White
Director of Research Ethics
Chair, Human Research Ethics Committee

Appendix J. Memorandum of Understanding for use of ACPMH data.

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Dr Maria Kangas
Senior Lecturer
Department of Psychology
Macquarie University
NSW 2109

5 September 2011

Dear Maria,

This letter concerns our understanding of the use of data owned by the Australian Centre of Posttraumatic Mental Health, University of Melbourne by Kate Baecher, a psychology student that you are supervising at Macquarie University.

I understand that Kate wishes to have access to the database known as the injury Vulnerability Study (IVS) database, and will write a thesis based on the data in the area of traumatic injury and how it impacts on mental health. I understand that this manuscript will be submitted by Kate for assessment for her postgraduate degree and will also be used as the basis for submitting a manuscript for publication.

ACPMH agrees that it will make available access to the IVS database to Kate for the purposes outlined in this letter. Kate will take lead authorship on these manuscripts, and other authors will take authorship positions determined by their contribution to the study and manuscript. The author list will include Darryl Wade, Meaghan O'Donnell, Mark Creamer, Alexander McFarlane, Derrick Silove and Richard Bryant because of the role they will play in providing supervision or have played in establishing the IVS database. Any manuscript prepared for publication using the IVS data must obtain prior approval from ACPMH before submission for publication, but submission of a manuscript for assessment for Kate's postgraduate degree will not require any such approval.

Kate will recognise that although the database is de-identified, she must respect the confidentiality of the database by not giving access to anyone (other than as necessary for her supervisors and Macquarie University statisticians assisting on the project) unless in discussion with Darryl Wade. She will return her copies of the database upon completion of her studies.

Finally, all parties acknowledge that the development of the IVS database was underpinned by a theoretical framework that impacts on how the data should be

interpreted. Differences in interpretation of the data will be negotiated in good faith with the aim of a successful resolution for the student. However, in the event of significant disagreement in the interpretation of data, ACPMH reserves the right to forgo approval of the publication of these findings.

Yours sincerely

Darryl Wade, PhD
ACPMH and The University of Melbourne
Level 1 340 Albert Street
East Melbourne 3002

Appendix K. Letter Outlining of the Use of IVS database approval, Macquarie University.

MACQUARIE UNIVERSITY

Research Office
MACQUARIE UNIVERSITY NSW 2109 AUSTRALIA
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October 2011

File No: 11/1463
Reference No: 8201100478

Dr Darryl Wade
ACPMH and the University Melbourne
Level 1 340 Albert Street
East Melbourne 3002

Dear Dr Wade

ACCESS TO INJURY VULNERABILITY STUDY (IVS) DATABASE

Thank-you for your letter date 5 September 2011, a copy of which is attached and marked Annexure 'A'.

Macquarie University accepts the terms and conditions set out in the letter concerning the IVS database. Any publications relating to the information held within the database will duly acknowledge the role of supervisors and the role of the persons involved in the development of the IVS database.

It is accepted that the information contained in the IVS database is to be accessed only by Kate Baecher, a psychology student at Macquarie University, supervisors and statisticians assisting on the project.

Macquarie University asserts that it owns any Intellectual Property generated by the research project by the student will be owned by the student.

Yours sincerely,

hancellor (Chief Operating Officer)

Correspondence to:
Attn: Patricia Fleming
Research Office
Building Level 3, C5C East
Macquarie University NSW 2109

DECLARATION OF THE PERSONS ACCESSING THE CONFIDENTIAL INFORMATION

I have read and understood the terms of letter outlining the conditions of access

m. baeche

Maria **Kate Baecher**

Dated

WWV