

Risk of Injury: The Implications of Mental Health, Alcohol and Gender

by

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B.A, University of British Columbia, 2011

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in the Department of Psychology

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## **Supervisory Committee**

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### **Supervisory Committee**

Dr. Timothy Stockwell, Department of Psychology  
**Supervisor**

Dr. Erica Woodin, Department of Psychology  
**Member**

## **Abstract**

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Injuries are a serious public health concern and identifying risk factors for injury is a research priority. Previous research consistently supports the link between alcohol and risk of injury and between mental health and alcohol use. There is also some research to indicate an association between mental health and risk of injury. Given the nature of these independent relationships, examining how these variables are inter-related could have significant implications for injury prevention and informing public health policies. There is however, a dearth of research examining how mental health and alcohol interact and contribute to injury risk. The present study examines the independent and shared contributions of mental health and alcohol to injury. Furthermore, gender differences in these relationships are examined. The results indicate both alcohol use and mental health are significantly associated with increased risk of injury. Moreover, a synergistic effect between alcohol and mental health on injury is found among women. The implications for these results in practice and policy are discussed.

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## **Dedication**

I would like to thank my parents for supporting me through out my entire education. You know when to push me, and when to offer me guidance and love. I don't think I could have gotten this far without you.

## **Risk of Injury: The Implications of Mental Health, Alcohol and Gender**

Injuries, both intentional and unintentional, are a serious public health concern. They are the single leading cause of death for Canadians under the age of 45, and the fourth leading cause of death for all Canadians, and the third leading cause of hospitalizations. Furthermore, the economic burden associated with injuries is estimated to be over \$12.7 billion per year (Public Health Agency of Canada, 2006). Given the substantial costs and harms associated with injuries, determining risk factors for injury has become a research priority.

Alcohol has been identified as one of the most prominent risk factors for injury reported, and injuries constitute 46% of the deaths attributable to alcohol (Rehm et al., 2004; Rehm et al., 2009). There is a substantial amount of literature indicating a strong relationship between alcohol use and injury. Much of this literature comes from emergency department studies, which can provide case-control and case crossover risk estimates. In case crossover designs, injured individuals serve as their own controls, based on their patterns of substance use and other behaviors in the past (Borges et al., 2004; Vinson et al., 1995); where as in case control designs non-injured ED patients are used as quasi-controls (Cherpitel, 2007; Ye, Cherpitel, & Bond, 2010). Although the methodological variations in ED studies results in a wide variety of injury relative risk estimates associated with alcohol, the finding that alcohol is one of the strongest predictors of injury leading to hospitalization remains consistent (Cherpitel, 2007; Rehm et al., 2009; Rehm et al., 2004). Given the importance of alcohol as a risk factor for injury, increased understanding in how alcohol contributes to injury has significant implications for the development of strategies



to reduce the risk contribution of alcohol to injuries. Although some strategies are already in effect (i.e., mass media campaigns, police initiatives to enforce impaired driving laws, and policies aimed at reducing the availability of alcohol), the knowledge base regarding effective, empirically supported prevention practices for alcohol-related injury is still relatively new. A better understanding of the process by which alcohol leads to injury, as well as other factors that may be involved, would greatly contribute to increasing this knowledge base.

Although the relationship between alcohol and injury is well documented, less is known about the possible role of varying levels of affect within this relationship. Previous research supports a relationship between negative affect and alcohol consumption; although the direction of this relationship is not always clear (Merikangas et al., 1998). The self-medication hypothesis indicates that individuals experiencing negative affect consume alcohol as a means of coping with the negative emotions (Khantzian, 1997). However, alcohol is also known to contribute to negative mood (Allan, 1995); therefore, the relationship between affect and alcohol is likely bi-directional. To a lesser extent, previous research also supports a relationship between mental health and injury, such that rates of both unintentional and intentional injuries tend to be higher among individuals with higher levels of negative affect or poorer mental health (Beautrais, 2001; Korniloff, 2012).

Given the nature of these independent relationships, examining how these variables are inter-related could have significant implications for injury prevention and informing public health policies. Nevertheless, there is a dearth of research examining how mental health and alcohol interact and contribute to injury risk. It is the goal of the present study to look at the independent and shared contributions of mental health and alcohol to injury.

Furthermore, gender differences in these relationships will be examined, as previous research has provided mixed results regarding gender variations in injury relative risk estimates associated with alcohol and mental health. More specifically, the present study seeks to answer the following research questions:

1. Is the dose response relationship between alcohol and injury risk significantly different for males and females?

2. Does the dose response relationship between alcohol and injury risk significantly vary according to the severity of self-reported poor mental health?

3. Is the relationship between alcohol, mental health, and injury risk significantly different for males and females?

The first section of this paper will provide a review of the literature that examines the relationships between alcohol and injury, mental health and alcohol use, and mental health and injury. The literature search was done primarily through the University of Victoria's search engines: Ebscohost and Google Scholar. The search was done using key words associated with this paper (i.e., alcohol, injury, mental health, injury risk etc.), and examining reference lists of relevant reviews. In order to provide relevant and up to date literature, most literature published prior to the year 2000 was excluded. As some of the topics discussed, (i.e., alcohol and injury) have an extensive amount of published literature there was a heavier reliance on comprehensive and systematic reviews.

### **Alcohol and Injury**

There is substantial amount of literature that demonstrates a strong association between alcohol and injury, much of which comes from emergency department (ED) studies (Cherpitel, 2007). Reviews focusing specifically on alcohol and injury in EDs have

consistently found that alcohol is more likely to be associated with injury compared to non-injury cases admitted to the ED, as well as to violence-related injuries compared to non-violence related injuries (Cherpitel, 1993; Cherpitel, 1994). Furthermore, the amount of alcohol consumed within the 6-hour period before an injury event is highly predictive of injury risk even after controlling for other contextual and individual factors (Macdonald et al., 2005; Stockwell et al., 2002). One study of four American EDs found that among participants suffering from a violence-related injury, 50% reported they had been drinking within 6 hours prior to the injury event (Cherpitel et al., 1993).

Different theories have been posited regarding the link between alcohol use and increased risk of injury. Some argue that an increase in injury is due to the fact that alcohol consumption tends to be associated with increased exposure to hazardous situations, such as drinking in bars where the likelihood of violence or assault is higher, or dangerous driving (Li, Smith, & Baker, 1994). Additionally, settings associated with alcohol consumption tend to influence behavior in a way that may put individuals at greater risk for injury. This theory is supported by the finding that the likelihood of an individual suffering from an alcohol-related violent injury significantly increases when alcohol consumption occurs in a bar or restaurant (Stockwell et al., 2002). Other situational factors impacting the relationship between alcohol and risk of injury have also been implicated. These include, but are not limited to: crowding, lack of entertainment, permissiveness, frustration, being with friends, and consuming alcohol on Friday and Saturdays and late at night (Graham, West, & Wells, 2000; Macdonald et al., 2005; Young et al., 2004). Although certain situational variables may moderate the relationship between alcohol and injury, alcohol still remains a significant risk factor even after controlling for these situational

variables (Macdonald et al., 2005; Stockwell et al., 2002). Therefore, more research is needed to determine other factors that are involved in the alcohol and injury risk relationship.

Another theory explaining how alcohol leads to injury focuses on the effects of alcohol. Researchers have argued that because alcohol interferes with coordination, reasoning, and balance abilities, injury occurs because of an individual's decreased capacity to perceive and/or respond to hazards (Graham et al., 2000; Malmivaara et al., 1993; Moskowitz & Fiorentino, 2000). For example, the pharmacological effects of alcohol can lead to poor coordination and poor balance abilities, thereby resulting in a greater likelihood of an individual sustaining injury from a fall. In fact, there is a notable linear relationship between risk of injury leading to hospitalization and amount of alcohol consumed. One study examining relative risks of injury in adults reported that the risk of sustaining an injury from a fall among heavy drinkers was double that of light drinkers (Malmivaara et al., 1993). Alcohol also impairs reaction times and other driving related skills, which is believed to be one of the main reasons for the increased risk of automobile accidents among impaired drivers. In a review (Moskowitz & Fiorentino, 2000) examining the effects of low-doses of alcohol on driving related skills the authors indicated strong evidence for any departure from a BAC of zero resulting in impairment of some driving related skills. Once BAC reached 0.050g/dl, the majority of studies reported alcohol impairment, and with a BAC of 0.080g/dl, 94% of all studies reviewed indicated alcohol related impairment of driving skills. Most notably, divided attention, wakefulness, psychomotor skills, and reaction time were most sensitive to the effects of alcohol and most likely to show significant impairment at low doses.

Additionally, other researchers have posited that alcohol is related to injury through the disinhibiting effects of alcohol. This theory has been widely examined in the field of alcohol-related aggression. A common mechanism by which alcohol is believed to lead to aggression is through the anxiolytic effect of alcohol, resulting in the disinhibition of fear (Lavine, 1997). Another line of research suggests that aggressive behavior following the ingestion of alcohol is a function of alcohol expectancies, such that individuals who believe alcohol will lead to aggressive behavior are more likely to engage in aggressive behaviors when under the influence (Chermack & Taylor, 1995). Similarly, some research indicates that alcohol may interact with specific personality or character dispositions, thereby increasing risk of injury only among certain individuals. For example, previous research has reported that among individuals with more aggressive dispositions, those who consume alcohol are more likely to display high levels of aggressive behavior compared to those who do not consume alcohol (Bailey & Taylor, 1991; Zhang et al., 1997). From these results, it is argued that alcohol may interfere with an individual's inability to plan out their actions in response to a situation, to evaluate the consequences, or to inhibit their ability to think of more than one course of action (Boles & Miotto, 2003; Graham et al., 2000). Although the causal link between alcohol and aggressive behavior is supported (Bartholow & Heinz, 2006; Chermack & Taylor, 1995), the theories posited regarding the mechanisms underlying this relationship are supported primarily by correlational data (Graham et al., 2000). Furthermore, there is no one theory that is supported more than the other; indicating that the process by which alcohol leads to injury is complex and likely involves inter-relations among several factors.

Although alcohol is a risk factor for all types of injuries, some research indicates that the strength of the association may vary according to different causes, types, and contexts of injuries. For example, injuries resulting from violence, crashes, falls, and fire/burns are the most common causes associated with alcohol involvement (Comptom et al., 2002; Hingson & Howland, 1993; Macdonald et al., 2005). The association between alcohol-related violent injuries is particularly strong, with an ED study reporting that 42% of patients admitted for violent injuries had a blood alcohol level over 80mg (Macdonald, Wells, Giesbrecht, & Cherpitel, 1999). Additionally, increased alcohol consumption and higher levels of blood alcohol content (BAC) has been associated with more severe injuries, as measured by number of body regions injured (Macdonald et al., 2006), and by severity level of injuries (Levy et al., 2004). In a study examining alcohol involvement in different types of injuries, those who consumed alcohol during the day were three times more likely to suffer a spinal cord injury and up to four times more likely to suffer a traumatic brain injury compared to participants who did not consume alcohol; however the risk for suffering a minor scald injury did not differ according to level of alcohol consumption. Furthermore, injuries leading to fatalities are significantly more likely to have involved alcohol compared to non-fatal injuries (Levy et al., 2004). This includes fatalities associated with automobile accidents; in accidents where drivers have been fatally injured, the drivers are significantly more likely to be alcohol impaired compared to those drivers less severely injured (National Highway Traffic Safety Administration, 2004). Finally, in regards to the context in which injuries occur, bars and restaurants significantly increase the likelihood of violent alcohol-related injuries (Macdonald et al., 2005; Macdonald et al., 2007). In fact, results from an ED study reported that 37% of violent injuries occurred in a bar or

restaurant compared to 3% of accidental injuries (Macdonald, et al., 1998). In contrast, alcohol plays a less substantial role in home-related injuries (Borges et al., 1994), as well as injuries occurring at work (Webb et al., 1994). Given these findings, further research that can lead to better understanding how alcohol contributes to injury will be useful in developing effective preventative and intervention methods.

The magnitude of the association between alcohol and injury also tends to vary quite considerably across studies, which can in part be attributed to socio-demographic characteristics and other socio-cultural factors of the population being studied (Cherpitel, 2007). For example, an ED study comparing Mexican Americans and Mexicans on levels of alcohol consumption among injured patients found that those in Mexico were less likely to report alcohol consumption and alcohol-related problems. More interestingly, the Mexican Americans reporting higher levels of acculturation were also more likely to report drinking prior to the injury event (Cherpitel & Borges, 2001). Other ED studies have reported that relative to patients admitted for accidental injuries and non-injuries, patients admitted for a violence-related injury are more likely to be male, have lower incomes and school attainment, and come from a blue-collar occupation (Borges et al., 2004; Macdonald et al., 2007). Similarly, analysis from an international ED study reported that being male, unmarried, and under the age of 45 increased the likelihood of an alcohol-related injury (Young et al., 2004).

The results from these studies indicate the importance of considering a variety of socio-demographic factors when examining the relationship between alcohol and risk of injury. Of particular importance is the consideration of gender, as levels of alcohol consumption and the impacts of alcohol have been found to differ between males and

females. Previous research on the dose response relationship between alcohol use and risk of injury has provided conflicting results regarding gender differences. Some studies report no gender differences, while others suggest that females are at a greater risk at a given dose. For example, one study reported an elevated risk for injury among women for any amount of alcohol consumed, where as among men, this elevated risk of injury was only seen when alcohol consumption exceeded 90 grams (Stockwell et al., 2002). Similarly, another study reported significantly higher risk of injury at most levels of reported alcohol consumption for women relative to men, even after controlling for other demographic variables (Mcleod, Stockwell, Stevens, & Phillips, 1999). In contrast, a review of risks and harms associated with alcohol inferred from the evidence that there was no empirical support for different drinking guidelines for men and women in regards to the quantity of alcohol consumed on one occasion (Ashley et al., 1994). One potential explanation for gender differences may be due to the differences in metabolism of alcohol by men and women. Women tend to reach higher BACs than men following the consumption of equal amounts of alcohol, even after controlling for body weight (Mumenthaler, Taylor, O'Hara, & Yesavage, 1999). In addition, some of these conflicting results may also be attributed to study design; ED studies using participants as their own controls have reported no significant gender differences, where as ED studies using non-injured patients as quasi-controls do report gender differences (Stockwell et al., 2002; Watt et al., 2004). There is also the possibility of gender bias in regards to attendance at EDs, as women are more likely to seek medical care for minor injuries than men (Bertakis et al., 2000). Given the mixed findings regarding gender differences in injury risk and alcohol consumption, further research is needed to better understand the role gender may play in this



relationship. This issue has significant implications in regards to advising the general public on low-risk drinking guidelines. As this is a fundamental issue, gender differences will be examined in the current study to gain further understanding on how gender plays a role in the relationship between alcohol and injury.

Finally, the variation in methodologies across ED studies has resulted in a wide variety of risk estimates. The two main designs in ED studies are case crossover designs and case control designs. In case crossover designs, injured individuals serve as their own controls, based on their patterns of substance use and other behaviors in the past (Borges et al., 2004; Vinson et al., 1995); where as in case control designs non-injured ED patients are used as quasi-controls (Cherpitel, 2007; Ye, Cherpitel, & Bond, 2010). ED studies using either method have reported alcohol as a significant risk factor for injury (Cherpitel 1993; Cherpitel 1997); however, case crossover designs tend to yield higher risk estimates than case control designs (Gmel & Daepfen, 2007; Ye et al., 2010). It is argued that using quasi-controls may not suffice as good controls because non-injured patients and injured patients are not likely to have similar drinking behaviors or drinking patterns (Cherpitel, 1993). In case crossover designs there is a reduction in confounding variables because of the stable within-person risk factors. However, there is still the limitation of environment or context factors and within-person factors that can impact the alcohol-injury relationship (Ye et al., 2010).

Given the mixed results of the different design methods, the current study will use both case crossover and case control designs. The case control design will allow us to compare injured with non-injured patients in order to examine between person differences with regards to injury risk and alcohol consumption. The case cross over analysis allows

for a usual frequency approach and a matched-pair approach. The usual frequency approach involves comparing the probability of alcohol use in the six-hour period prior to the injury event with probabilities estimated on the basis of self-reported usual consumption. The matched-pair approach involves comparing the probability of alcohol use in the six-hour period prior to the injury even with the exact same time period 24 hours earlier and seven days earlier. The usual frequency approach typically yields larger risk estimates, which is thought to be a result of recall bias (Ye et al., 2010; Stockwell et al., 2008). Further discussion of the intended analyses will be discussed in the methods section of this paper.

### **Mental health and Alcohol use**

The relationship between mental health and alcohol use has been widely studied, with a prominent focus on testing the self-medication hypothesis. The self-medication hypothesis states that individuals experiencing negative affect consume substances as a way of coping with these negative feelings (Khantzian, 1997). With regards to alcohol, it is argued that alcohol can help alleviate feelings of depression, sadness, and anxiety and therefore, individuals reporting higher levels of these symptoms are also more likely to display higher levels of alcohol consumption (Bolton, Robinson, & Sareen, 2009). Research testing the self-medication hypothesis has produced conflicting results that have generated debate regarding the validity of this theory. Nonetheless, many studies have found support for this hypothesis across a variety of different populations.

Some of the support for the self-medication hypothesis is derived from the comorbidity rates of substance use disorders with mood disorders. According to the National Institute on Drug Abuse (2007), it is estimated that approximately 60% of

individuals with a substance use disorder also suffer from another form of mental illness. Furthermore, the co-occurrence of a substance use disorder with a mood or anxiety disorder is one of the most common clinical displays of comorbidity (Quello, Brady, & Soone, 2005). In addition, there has been research examining the association between depressive symptoms with alcohol consumption. Several studies on college students have reported that higher levels of alcohol consumption are associated with greater severity of depression (Dawson, Grant, Stinson, & Chou, 2005; Geisner, Mallett, & Kilmer, 2012; Weitzman, 2004). The results of these studies indicate that mental health and alcohol use are related; however these studies have been primarily correlational and therefore, do not provide support for the causation effect indicated in the self-medication hypothesis. Nonetheless, if poor mental health and alcohol use are positively correlated, considering mental health factors when examining alcohol and the risk of injury may be useful in further understanding this relationship.

Although the rates of comorbidities and correlation studies demonstrate that substance use and mood and anxiety disorders commonly occur together, they do not provide any indication of the underlying mechanism of this association. Previous research examining the causal link between substance use disorders and other forms of mental illness has consistently provided mixed findings. Some researchers have reported that a substance use disorder is a direct cause of a mood or anxiety disorder (Allan, 1995; Schuckit & Hesselbrock, 1996), while others have argued that certain forms of mental illness can lead to substance use through methods of self-medication (Kushner et al., 1996; Kushner, Sher, Wood, & Wood, 1994). There is some empirical support for the onset of anxiety disorders to have a higher likelihood of preceding substance use disorders;

however the results are still far from being conclusive (Merikangas et al., 1998). In addition, others have argued that the causal relationship between substance use disorders and other forms of mental illness is bi-directional and determining temporal precedence is not possible (Kessler et al., 1997; Swendsen & Merikangas, 2000). A review examining international patterns of comorbidity between substance use and other mental disorders led Merikangas and colleagues (1998) to conclude that there is no definite temporal pattern of onset for substance use disorders in relation to mood disorders. Similarly, another review supports the finding that mood, anxiety, and alcohol use disorders serve to initiate and continuously contribute to the maintenance of each other (Kushner, Abrams, & Borchardt, 2000). There is also the added complication of withdrawal symptoms, which are commonly experienced by most individuals with a substance use disorder when they have stopped taking the alcohol or drug for a certain period of time. The withdrawal symptoms can be a major component of a mood disorder, making it more difficult to determine any temporal directionality between mental health and alcohol use (Preda et al., 2012). For example, some individuals experiencing alcohol withdrawal report dysphoria, fatigue, insomnia, anxiety, reduced sexual interest, and mood instability; all of which are also symptoms of Major Depressive Disorder (SAMHSA, 2005).

A similar line of research regarding the self-medication hypothesis focuses on states, instead of traits or disorders, and examines whether negative moods, depressive or anxiety symptoms, and feelings of sadness can predict alcohol consumption and alcohol-related problems. Additionally, drinking motives are examined to determine whether coping motives can explain the relationship between mood state and alcohol consumption. The basis for examining motives for drinking derives from motivational theories of alcohol use.

These theories posit that an individual's decision to drink or not is dependent on a complex interplay of situational, cognitive, and emotional factors. The balance of these factors results in an individual's desire to drink for specific reasons, with the underlying goal to regulate positive and negative emotions (Cooper, Frone, Russell, & Mudar, 1995; Cox & Klinger, 1990). Typically, the research on drinking motives has conceptualized three distinct reasons to drink: coping motives, social motives, and enhancement motives. According to Cooper and colleagues (1995), coping motives are similar to the self-medication hypothesis, in which individuals drink to cope with negative emotions. Enhancement motives are defined as drinking to enhance positive mood or well-being and social motives are conceptualized as drinking to obtain social rewards. More recently, a fourth motive was included in the model, which is conformity motives or drinking to avoid social rejection (Kuntsche, 2007). Previous research examining the relationship between drinking motives and alcohol consumption indicate that coping motives and enhancement motives are most strongly associated with heavier alcohol use and more alcohol related problems (Kuntsche et al., 2005; Kuntsche, Knibbe, Gmel, & Engels, 2006).

In line with the self-medication hypothesis, research has provided support for the theory that coping motives lead to higher levels of alcohol consumption and alcohol-related problems (Abbey, Smith, & Scott, 1993; Kuntsche, 2007). Moreover, research examining different mood states and drinking motives has provided further support for the motivational model of alcohol and led to an increased understanding of the link between mood and alcohol use. For example, studies of college students indicate that among individuals high in drinking to cope motives, experiences of moderate to high levels of fear, shyness, and sadness predict daily drinking (Hussong, 2007; Hussong, Galloway, Feagans,

2005). The authors of these studies argued that coping motives are not only a reason for drinking, but may be an indicator of a more risky and uncontrolled style of drinking. This argument is in line with findings from other studies that suggest coping motives are more strongly associated with drinking and drinking problems relative to enhancement or social motives (Cooper, Frone, Russell & Mudar, 1995).

In addition to coping motives moderating the effect between negative mood and amount of daily alcohol consumption, they may also predict onset of drinking. For example, in the study by Hussong (2007), the results indicated that for those with higher coping motives there was a shorter time interval between distress and drinking, especially among men. Another study examining the predictive value of mood states on the onset of weekly drinking found that for those participants with high coping motives, there was early initiation of drinking in high anxiety weeks relative to low anxiety weeks. In contrast, among individuals with low coping motives, later initiation of drinking was seen in high anxiety weeks compared to low anxiety weeks. Interestingly, the opposite effect was found for anger, with weekly drinking onset being initiated later in high anger weeks relative to low anger weeks (Armeli, Todd, Conner, & Tennen, 2007). The authors explain that self-regulation processes may explain their findings, such that individuals with high coping drinking motives may have more difficulty regulating their emotions and therefore, resort to drinking earlier during high anxiety weeks. Additionally, individuals with higher coping motives may be more resistant to social norms of drinking and therefore, decide to drink regardless of social constraints that may lead individuals with low coping motives to drink later in the week when it is considered more socially acceptable (Armeli et al., 2007; Hussong, 2007).

Feelings of neuroticism have also been linked with alcohol consumption; however the mechanism underlying this association may be slightly different. A study examining affect and risk behaviors among young adults reported that individuals scoring higher on neuroticism were more likely to engage in riskier behaviors and report heavy drinking and alcohol problems. Moreover, neuroticism predicted coping motives for drinking and these motives also predicted heavy alcohol use and problems. The authors argued that neurotic individuals are more likely to engage in risky behaviors as a way of coping with their aversive mood states (Cooper, Agocha, & Sheldon, 2000). A related study reported similar results; however gender differences were indicated. More specifically, the relationship between neuroticism and coping motives was stronger for females, whereas males were more likely to show a pattern of sensation-seeking, impulsiveness, and enhancement motives for drinking (Kuntsche et al., 2006). Both patterns were associated with riskier drinking and alcohol problems, indicating that the mechanism underlying the association between mood, motives, and drinking may be different for males and females. The results of these studies indicate that there may be a specific population at risk for experiencing alcohol-related problems. More specifically, there may be a subgroup of individuals experiencing negative or poor mental health symptoms that engage in risky drinking behaviors as a coping method, which in turn puts them at higher risk of injury.

Although there is an accumulation of research corroborating the motivational model of drinking, some researchers argue there is no strong empirical support for mood-motive-alcohol use relations. For example, a daily diary study investigating the impact of daily mood and motives on alcohol consumption reported that there is no indication that individuals with higher drinking to cope motives are more likely to drink after

experiencing negative mood. Moreover, any effects of mood and motives on alcohol consumption that were observed were moderated by other risk factors for drinking, such as sex (Littlefield, Talley, Jackson, 2012). In addition, a cross sectional public health study examining the association between mental health and binge drinking among Dutch adolescents reported that participants with mental health problems were more likely to be binge drinkers than those without mental health problems; however, this relationship was found among adolescents aged 12-15 and became non-significant as they reached adulthood. The authors argued that this could be an indication that coping motives are a predictor of alcohol use only among youth (Theunissen, Jansen, & van Gestal, 2011). An explanation for these inconsistent findings could be that there are unique triggers associated with subtypes of coping motives for drinking. More specifically, a study of college students examining specific mood triggers reported that coping-anxiety motives moderated the relationship between daily anxious mood and alcohol consumption and coping-depression motives moderated the relationship between daily depressed mood and alcohol use. However, there was no interaction between the different types of coping motives and alcohol use (Grant, Stewart, & Mohr, 2009). The results of the study indicate the importance of considering how specific drinking motives impact the relationship between certain states of negative affect and alcohol consumption.

Although research supports the idea that some individuals may use alcohol to cope with anxiety or depression, there are mixed results in regards to whether alcohol actually works to reduce feelings of negative affect. According to the tension-reduction hypothesis, individuals consume alcohol to achieve tension reduction (Kalodner, Delucia, & Ursprung, 1989). Some studies have indicated that alcohol does have a tension reduction effect



(Higgins & Frazell, 1981), whereas others have not been able to demonstrate a significant alcohol-specific reduction in tension (Lipscomb, Nathan, Wilson, & Abrams, 1980).

Additionally, some studies demonstrate bidirectional processes whereby heavy consumption in the short-term may provide some relief but in the longer term it fuels worsening mood, particularly higher anxiety (Stockwell, Hodgson, & Rankin, 1982; Stockwell, Smail, Hodgson, & Canter, 1984). There have also been mixed findings regarding the dose-response relationship between alcohol and tension. Some studies report tension reduction effects at low doses of alcohol and increases in tension at higher doses (Hull, 1981; Vanicelli, 1972). Other studies have found that moderate doses of alcohol can lead to a reduction in anxiety (Polivy, Schuenemen, & Carlson, 1976), induce anxiety, or have no effect (Dengerink & Fagan, 1978; Young, Oei, Knight, 1990). Additionally, short-term alcohol use may have tension reduction effects, but long-term heavy alcohol use is known to contribute to increases in anxiety (Breese, Overstreet, & Knapp, 2005). In a review examining the tension-reduction hypothesis (Young et al., 1990) the authors argue that these inconsistencies may be due to alcohol-related expectancies. More specifically, alcohol expectancies have been found to mediate the relationship between consumption and tension reduction such that tension reduction effects are seen only among those individuals who expect alcohol to produce these effects (Cappell & Greeley, 1987; Wilson, Abrams, & Lipscomb, 1980). Overall, the literature remains variable regarding alcohol-specific tension reduction effects. There is relatively more support for the idea that tension reduction may be seen among individuals who consume alcohol to cope and hold the belief that alcohol will help in reducing their anxiety. Given the inconsistent findings, more research is needed to further elucidate the relationship between mental health and alcohol use. Further

understanding of this relationship can lead to more effective intervention and prevention strategies, as the pathways to risky drinking may be different for individuals presenting with and without other mental health symptoms.

As is the case with the association between alcohol and injury, there is some indication of gender differences in the relationship between mental health or mood states and drinking. However, the research reporting on gender differences has provided inconsistent and mixed results. For example, Hussong (2007) reported that although there was a significant relationship between high coping motives and alcohol consumption following days of elevated sadness for both sexes, the association was stronger for women. Additionally, women in this group were also more likely to experience alcohol-related problems, where as this association was not found among men. Some research has indicated that women are more likely to endorse coping motives, where as men are more likely to show enhancement motives (Cooper et al., 1992; Kuntsche et al., 2005). On the other hand, a national epidemiological survey on self-medication reported that men are more than twice as likely as women to engage in self-medication behaviors, such as drinking to reduce emotional distress (Bolton, Robinson, Sareen, 2009). Although the findings are somewhat mixed, research generally indicates a complex relationship between gender, mental health, and alcohol use. Moreover, a trend in gender differences does appear across different studies. More specifically, previous research suggests that there is a stronger relationship between distress and heavy drinking among men (Cooper et al., 1992; Hussong et al., 2001); however, there is a greater risk for women who display a co-occurrence of depression and alcohol use disorder (Hussong, 2007; Zucker, 1986). Given these findings, the current study will examine whether gender differences exist in the

relationship between mood state, alcohol use, and risk of injury, as this could have significant implications for informing the general public, practitioners, and policy makers.

### **Mental Health and Injury**

The link between mental health and injury is a relatively new area of study and little is known about the nature of this relationship. Some support has been found for an association between poor mental and injury. For example, in a report on youth and injury issued by the Public Health Agency of Canada (2012), youth who reported injuries in the past year also had higher scores on the behavioral problem scale, which is an indicator of negative mental health. Further, girls who reported injuries also showed increased scores on an emotional problems scale. What was more interesting were the relationships found between mental health and types of injury. For example, higher rates of emotional wellbeing were associated with physical activity injuries, while higher rates of emotional problems were associated with injuries caused by fighting. Finally, higher scores on the behavioral problem scale were associated with more risk-taking behaviors such as drinking and driving. Based on these results, it was argued that individuals with emotional problems might be at a higher risk for injury through mechanisms such a risk-taking behaviors. However, given that this report was correlational, there is no way to determine the causal relationship between negative mental health symptoms and injury.

A more prominent area of research in mental health and injury has focused on the association between depressive symptoms and injury. Both cross-sectional and longitudinal studies focusing on different populations have found similar results that support a link between depression and injury. Some researchers have argued that this link between may be explained by intentional self-injury or suicidal attempts, which is more

common among depressed or anxious populations (Beautrais, 2001). In a sample examining self-injury among university students, the results indicated that students who had depressive and anxiety disorders had a much higher likelihood of reporting self-injury in the past month relative to students without a disorder (Gollust, Eisenber, & Golberstein, 2008). Similar to the self-medication hypothesis, the link between mental health and self-injurious behaviors may be explained by difficulties in self-regulation. Individuals who have engaged in self-injurious behaviors report experiencing anxiety, depression, hopelessness, or general distress, and the self-injurious behavior is associated with a sense of release or temporary relief (Muehlenkamp, 2005). Although self-injury may contribute to explaining some of the variance associated with mental health and risk of injury, self-inflicted injury represents only a small percentage of injuries presented in emergency room studies (Whetsell, Patterson, Young, & Schiller, 1989). Further, there is evidence to suggest that mental health is associated with other injuries that fall outside of intentional self-harm behaviors.

Research examining poor mental health and unintentional injury indicates that there is in fact a relationship between the two. For example, a study comparing the relationships between physical activity and depressive symptoms among a Finnish population reported that physical activity was not related to unintentional injuries, whereas depressive symptoms were. In fact, among participants with depressive symptoms the proportion of individuals reporting unintentional injuries was almost double that of participants without depressive symptoms (Korniloff, 2012). Another study examining the link between depression and occupational injury found a relationship between pre-existing depressive symptoms and higher injury rates; however this relationship was only seen

among women (Peele & Tollerud, 2005). Finally, a longitudinal study reported a bi-directional association between major depressive episodes (MDEs) and injuries; participants with MDEs had a 60% increased risk of injury and among those reporting an injury, 6.4% developed an MDE two years later. In regards to MDE as a risk factor for injury, the association appeared to be stronger among participants aged 12-18 and no gender differences were found (Patten, Williams, Lavorato, & Eliasziw, 2010).

There has been speculation regarding the theory behind the relationship between depression and unintentional injuries. Some researchers have argued that the increased frequency of injury can be attributed to antidepressant medication (Moden, Ohlsson, Merio, & Rosvall, 2011; Woolcott et al., 2009). Many antidepressants can have side effects that negatively impact coordination, cognition, alertness, and psychomotor function, which would in turn increase the risk for injuries (Edwards, 1995; Moden et al., 2011). However, other studies have reported an increased risk of injury regardless of antidepressant use (Korniloff, 2012; Tiesman et al., 2006), suggesting that the process by which depression leads to injury needs further examination. Other researchers attribute the association between psychological symptoms and injury to increased risk behavior (Barkley et al., 1993; Brooks, Harris, Thrall, & Woods, 2002; Chen et al., 2005). As stated by the Public Health Agency of Canada (2012), individuals with poorer mental health may be more likely to engage in risky behaviors, thereby increasing the likelihood of injury; though, the reasons for this is still largely unknown.

In addition to depressive symptoms, some studies have also linked other psychological symptoms to injury. For example, a prospective study examining nonfatal unintentional injuries among Chinese adolescents reported that somatization, obsessive-

compulsiveness, interpersonal-sensitivity, depression, anxiety, and psychotism were all associated with an increased injury risk, even after controlling for demographics (Chen et al., 2005). Relatedly, another study by Poole and colleagues (1997) examined differences in psychopathologic risk factors among individuals reporting intentional and nonintentional injuries and found similar results. Overall, individuals with either type of injury showed higher levels of depression, antisocial personality, and alcohol and drug use. Participants presenting with intentional injury were most likely to have met diagnostic criteria for at least one category of psychopathology, followed by the unintentional injury group and the control group. The authors argued that although there are other social factors involved, the higher levels of alcohol use, psychopathologies, and high-risk behaviors among trauma patients play a critical role in sustaining injuries requiring hospitalization (Poole et al., 1997). Additionally, in the study by Cooper and colleagues (2000), neuroticism predicted drinking problems across all levels of impulsivity; however, among participants low in impulsivity, neuroticism was less strongly related to coping motives. These results indicate that individuals who are both high in neuroticism and impulsivity have a greater reliance on alcohol to cope, thereby resulting in riskier alcohol-related behaviors.

Not only has mental health been indicated as risk factor for injury, but it may also be a contributing factor in injury recidivism. For example, among a sample of patients admitted to a trauma center for unintentional injury, 20% had a diagnosis of a mental illness. Those individuals with a mental illness were 4.5 times more likely to have injury recidivism compared to those without a mental illness diagnosis. Although there was significant overlap between substance abuse and mental illness in predicting injury recidivism, mental illness was found to be a stronger predictor of injury recidivism after

controlling for the shared variance between the two variables. The way in which the injury occurred also differed, with those with a mental illness more likely to be injured as a result of falling or being hit by a car (Wan et al., 2006). Together, the results of these studies provide some support for the argument that injury recidivism is not a random event, but a chronic condition in which individuals experiencing re-occurring injuries may be experiencing the consequences of their own high-risk behaviors (Poole et al., 1997; Poole et al., 1993; Wan et al., 2006).

As this area of research is relatively new, little is known regarding the role gender may play in the relationship between negative affect and injury. Some studies have indicated a possible gender difference in the association between depressive symptoms and mental health. For example, in a study identifying risk factors for unintentional adult injury in a rural population, both alcohol use and depressive symptoms were associated with injury frequency. However, the association between depressive symptoms and injury was much stronger among females, whereas the association between alcohol use and injury was stronger for males (Nordstrom, Zwerling, Stromquist, Burmeister, & Merchant, 2001). There have been a few other studies supporting the finding that depressive symptoms are a higher risk factor for injury among women; however the reasons behind this are still largely unknown (Forsen et al., 1999; Whooley et al., 1999). In contrast, one study reported that among participants admitted to a trauma center for unintentional injury, men were more likely to have a mental disorder; however, once substance abuse was excluded, there were no significant gender differences (Dicker et al., 2011). Overall, the majority of studies examining the association between mental health or negative affect and

injury risk do not report on gender differences; therefore, there is a general gap in the current knowledge base.

Given the paucity of research regarding gender differences in the relationship between mental health and injury, the current study will examine whether the relative risk of injury associated with negative affect is different for males and females. The clinical implications of these findings may be significant as injury prevention is a focus for many regulatory bodies. Understanding the role gender plays may be useful in informing public health officials and policy makers, and contribute to more effective injury prevention strategies.



## The Current Study

The aim of the current study is to examine the inter-relationships between mental health, gender, alcohol use, and injury, which to date have not been extensively studied. Most of the research in this area is done in emergency room studies or substance use treatment centers or programs. Emergency room department studies indicate that individuals presenting with an injury at the ER tend to both have higher BAC levels and be more likely to show signs or symptoms of a mental illness (Borges et al., 2004). In substance use treatment studies, individuals with a substance use disorder and a comorbid mood disorder also report higher frequencies of injury (Chen et al., 2005; Poole et al., 1997). These findings indicate a link between mental health, alcohol use, and injury, but they do not explain the nature of this relationship. Moreover, previous literature supports a link between negative mental health symptoms and heavier alcohol consumption (Dawson et al., 2005; Geisner et al., 2012; Weitzman, 2004) and a link between alcohol consumption and higher risk of injury (Cherpitel, 2007; Rhem et al., 2009; Rhem et al., 2004), but there is a lack of research testing these predictors simultaneously.

The current study will examine the relationships between mental health, alcohol use, and, injury. Moreover, given previous literature suggesting gender differences, the current study will examine whether these relationships differ between males and females. More specifically, using data collected from a previous emergency department study, the current research project will address the following major research questions and associated hypothesis:

1. *Is the dose response relationship between alcohol and injury risk significantly different for males and females?* Previous research studies using different designs, in different countries

and with different degrees of control for confounding variables have produced conflicting results, with some reporting greater risk for females at a given dose and others reporting no gender differences. As some ED case-control studies and population-based case-controls indicate a gender difference (Stockwell et al., 2002; Watt et al., 2004; Wells et al., 2007), we hypothesize that the risk relationship will be greater for females compared to males.

2. *Does the dose response relationship between alcohol and injury risk significantly vary according to the severity of self-reported poor mental health?* There is a lack of research regarding this relationship and previous has provided conflicting results, with some suggesting there no relationship and others reporting a relationship between poor mental health and alcohol use on injury risk. Given that research supports a link between negative mental health symptoms and heavier alcohol consumption (Dawson et al., 2005; Geisner et al., 2012; Weitzman, 2004) and a link between alcohol consumption and higher risk of injury consistent (Cherpitel, 2007; Rhem et al., 2009; Rhem et al., 2004), we hypothesize that the slope of the risk relationship will be greater for individuals reporting higher levels of negative mental health symptoms.

3. *Is the relationship between alcohol, mental health, and injury risk significantly different for males and females?* The lack of research has provided little knowledge regarding gender differences in the relationship between mental health, alcohol use, and injury risk. However, given we predict the slope of the risk relationship between alcohol use and injury will be greater for females, we predict the strength of the association between alcohol, mental, and injury will also be greater for females. More specifically, we predict an interaction effect such that mental health in combination with alcohol will interact synergistically to greatly increase injury risk when both are present.

## Methods

The current study will be doing secondary data analysis on an emergency department study that was conducted by the Centre for Addictions Research BC between 2008 and 2011. Data were collected from representative samples of ED patients at Vancouver General Hospital in Vancouver, and Royal Jubilee Hospital in Victoria. *Vancouver General Hospital* (VGH) is a 955-bed specialist level 1 trauma centre providing specialized and tertiary medical services to over 80,000 residents annually in Vancouver. VGH is the largest hospital in British Columbia and accepts patients referred from other parts of the province requiring highly specialized services. VGH is also a teaching hospital in affiliation with the University of British Columbia. *Royal Jubilee Hospital* (RJH) in Victoria is a 425-bed acute care facility located about 3km outside of the city centre. RJH offers critical-care, surgery, diagnostics, emergency facilities and other patient programs with a particular focus on cardiac medicine. RJH serves the downtown population as well as the surrounding areas. All statistical analyses were conducted using SAS 9.3.

### Participants

There are a total of 1229 participants, with 812 being non-injured patients and 417 injured. Participants ranged between the ages of 17-76 with a mean age of 36.88. There is an equal distribution of males (50.2%) and females (49.8%) and participants are primarily white (70.6%). The majority of participants are either married or single, never married and 68.9% have completed some form of post-secondary education or training.

### Procedure

All data was collected on Friday and Saturday nights between 10:00PM and 5:00AM. In each ED, patient samples aged 18 and over were drawn from computerized registration

available on the ED computer, entered in consecutive order of patient arrival at the ED, for both those that arrive on their own and those that arrive by ambulance. Non-injured patients were asked if they believed the medical problem for which they were seeking treatment was in any way connected with their drinking or drug use, or if they had reduced their drinking or drug use because of illness in the previous 30 days, and if so, were excluded from the sample.

Sampled patients were approached as soon as possible after registering for care with a request for informed consent to provide a breath sample and to be interviewed. Research assistants that were specifically trained for this study by the Centre for Addictions Research B.C conducted all interviews. The interviews lasted about 25 minutes, were completed either in a private area in or near the waiting department or in the treatment department. In the case of those who were severely impaired, every attempt was made to interview the patient at a later time. Those patients who were too seriously ill or injured to be approached or interviewed in the ED were followed into the hospital and interviewed after they have been admitted and their condition stabilized. Patients were offered a \$10.00 gift card for completing the interview. This methodology has been used in our prior ED studies in both the U.S. and Canada, and has proven acceptable to both patients and ED staff, and successful in obtaining high completion rates.

## **Measures**

**Patient interview and injury variables:** Patients were interviewed regarding the cause of injury (including violence) or medical problem which brought them to the ED, alcohol use, and other substance use within six hours prior to the event, and within the same six-hour period the previous day and the previous week (for case-crossover and control-crossover

analyses), the amount of alcohol consumed, time lapsed between drinking and other substance use and the event, feeling drunk at the time, believing the event would not have happened if he or she had not been drinking alcohol and/or using stimulants (including caffeinated drinks) or other drugs, usual use of alcohol and other substances (licit and illicit), and demographic characteristics.

Additionally, data was obtained on the place where the patient was and the specific activity the patient was engaged in at the time of injury (or first awareness of the medical condition bringing the patient to the ED), as well as for the same time the day before and the week before the injury event, for case cross-over and control-crossover analysis. Such measures have been utilised in previous studies (e.g. Stockwell et al, 2002) and in the BC preliminary studies to date. The place of injury was categorised as to the respondent's home, workplace (school/trade area/office), recreation or sporting areas, premises licensed for the sale of alcohol, an industrial area, and a street or "other". Activity at time of injury (or medical problem) was classified as to passive activities (reference group), sports, household chores or domestic activities, travel, working to earn money, social activities and "other" activities. ICD-10 diagnoses for each patient was subsequently extracted from medical records along with ratings of injury severity and whether the patient was admitted to hospital or discharged.

**Blood Alcohol Level:** The Alco-Sensor III breathalyzer provides estimates of blood alcohol which have a Pearson's correlation coefficient as high as 0.96 for oral exhalation among cooperative patients when compared to chemical analysis of blood (Gibb, et al., 1984). Previous analyses (e.g. Stockwell et al, 2002) have found that self-reported alcohol consumption has a higher incidence than positive breath tests, with very few reporting not

drinking when registering positive for BAC (less than .05% in some studies) (Cherpitel et al., 1992).

**Self-reported alcohol use:** The main outcome of interest will be self-reported alcohol use. The interest in obtaining breathalyzer readings to estimate BAC stems from prior research which has successfully mapped breathalyzer readings to the actual number of drinks consumed prior to injury, up to a threshold level of six drinks, and will, therefore, be a useful alternative for some patients who are not able to report the number of drinks consumed prior to the event bringing them to the ED (Bond et al., 2010). Self-reported alcohol use is measured by asking participants how many standard drinks they consumed in the 6-hour period prior to the injury or illness event, the same 6-hour period the week the injury event or illness, and alcohol use in the previous 12 months.

**Alcohol dependence:** A measure of alcohol dependence will be obtained, using the Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al, 1993). This is a 10-item questionnaire that asks about frequency of drinking (i.e., how often do you have 6 or more drinks on one occasion?), dependence symptoms (i.e., how often during the last year have you failed to do what was normally expected of you because of drinking?), and harmful alcohol use (i.e., have you or someone else been injured as a result of your drinking?). Scores can range from 0-40, with scores of 16 or higher suggesting a high level of alcohol problems and scores of 20 or higher suggesting alcohol dependence. This measure was developed for a large World Health Organization of detection and brief intervention for early stage problem drinking. The AUDIT has been found to be highly valid and reliable in different clinical and community samples through out the world (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Some studies have shown those with alcohol dependence

may be at lower risk of injury, possibly due to tolerance (Borges, et al., 2006) while others have not found this association (Cherpitel et al., 2010). A reliability analysis was conducted and the internal consistency of the scale in this dataset is  $\alpha = .89$ .

**Mental health:** Mental health was assessed using the Mental Health Index (MHI-5). This is a five-item mental health subscale from the Medical Outcomes Study Short Form Health Survey (SF-36; Ware & Sherbourne, 1992). The SF-36 was developed to assess patient functioning in medical settings, and assesses a range of physical and mental health factors. The MHI-5 was designed to assess mental health functioning within the previous month, and includes items tapping overall psychological wellbeing, as well as symptoms of anxiety and depression (i.e., during the last month, how much of the time have you been a happy person? During the last month how much of the time have you felt downhearted and blue?), delivered in a six-option Likert scale format (Veit & Ware, 1983). Higher scores indicate better mental health functioning. The MHI-5 demonstrates good internal consistency ( $\alpha = .88$ ; Stewart, Hays, & Ware, 1988) and has been shown in numerous studies to demonstrate good criterion validity when used as a screening tool for various mood and anxiety disorders confirmed through diagnostic interviews (e.g., Berwick et al, 1991; Means-Christensen, et al, 2005). The internal consistency of the MHI-5 in this study was  $\alpha = .80$ .

### **Statistical Plan**

Hypothesis 1: *Is the dose response relationship between alcohol and injury risk significantly different for males and females?*

Hypothesis 1 will be examined using both the case crossover and case-control methods. Using both case-crossover and case-control methods will allow us to

contrast the results. Previous research has indicated that these different methods of analyses can produce varying risk estimates and there are benefits and limitations to both (McClure, 1991; Ye et al., 2010). The case-crossover analyses will allow for the reduction in confounding variables due to stable within person risk factors; however, it does not allow for the control of transient within person factors or environmental and contextual factors. The case-control method will allow us to control environmental and contextual factors that could impact the alcohol and injury risk relationship. The use of both methods will allow us to gain a better understanding of the nature of the relationship between alcohol, mental health, and injury.

The case crossover analysis will be performed using conditional logistic regression, which will be fitted separately for men and women to estimate the relevant odds ratios (ORs) as risk estimates. The case period is the 6-hour period prior to the injury and the control time is the same 6-hour period one-week before. Patient data will be re-structured with two periods clustered under each individual, and the case period coded as injury and the control period coded as non-injury. Finally, to adjust for potential biases and the loss of efficiency when concordant pairs are eliminated from the analysis, we will perform a sensitivity analysis through randomly artificial adjustment of exposure levels (McClure, 1991).

To perform the case-control analyses logistic regression will be fitted separately for men and women, to produce risk estimates for injured and non-injured presentations. Potential confounding factors will be adjusted as covariates entered in the logistic regressions. It is predicted that at any level of alcohol consumption, injury risk will be significantly higher for females than males. The difference in the dose-response



relationship between alcohol consumption and injury risk between males and females will be investigated by comparing the gender-specific estimates with  $\chi^2$  test of homogeneity assessing whether the effects differ across gender (Rothman and Greenland, 1998).

*Hypothesis 2: Does the dose response relationship between alcohol and injury risk significantly vary according to the severity of self-reported poor mental health?*

Hypothesis 2 will also be examined using the case-control approach. The case-control analyses will be performed using logistic regression with mental health status and alcohol use entered as the independent variables in the regression predicting injured versus non-injured presentations. The estimation of the joint effect of alcohol and negative mental health symptoms can be conducted by adding an interaction term in the model. Testing of the joint effect is performed either by the Wald test or the likelihood ratio test. Potential confounding factors will be adjusted as covariates entered in the logistic regressions. It is predicted that for those individuals reporting higher levels of mental health symptoms, the dose response relationship between alcohol and injury risk will be higher.

*Hypothesis 3: Are the relationships between alcohol, mental health, and injury risk significantly different for males and females?*

Hypothesis 3 will be tested in a similar manner as hypothesis 2. The case control analyses performed to test hypothesis 2 will be rerun with interaction terms for sex and alcohol use, sex and mental health symptoms, and a three-way interaction term with sex, alcohol use, and mental health. In order to get separate risk estimates the analyses will be rerun separately for males and females. Potential confounding factors will be adjusted as covariates entered in the logistic regressions. Given our prediction for hypothesis 1, we

predict that the risk relationship between alcohol, mental health, and injury will also be higher among women.

## Results

The data was checked for missing data and 19 cases were found to have missing data. Given the nature of the data collection and the population this number is not unexpected; moreover, the missing data was missing at random and since our sample has a large N we excluded these 19 cases from the analyses. The alcohol use variable had a wide range, with individuals reporting anywhere from 0-56 drinks in the 6-hour period prior to their injury or illness and from 0-52 drinks the same 6-hour period 1 week prior. While it was assumed that this high level of alcohol consumption was unlikely, we presumed the actual alcohol amount was still large. In order to avoid the potential impact of extreme outliers, we censored the high levels of alcohol consumption using an upper limit of 20; therefore, all participants were still included in the analyses but any participants reporting more than 20 drinks were recoded as 20 drinks, Both variables were positively skewed with the majority of participants, 76%, reporting no alcohol consumption in the 6 hours prior to their injury or illness, and 85% reporting no alcohol consumption the same 6-hour period 1 week prior. There was a wide range of scores on the MHI-5, with participants scoring anywhere from 2-26. The mean score on the scale was 19.24 (SD= 5.43). The distribution was negatively skewed, with a higher number of individuals scoring between 20-25. While the non-normality of variables would be problematic in most GLM analyses, logistic regression is a fairly robust analysis that avoids the issue of the violation of normality (Tabachnick & Fidell, 2013). In order to better compare the dose-response relationship, number of drinks was recoded into five categories: 0 drinks, 1 drink, 2-3 drinks, 4-5 drinks, and more than 6 drinks. To determine which covariates to include in the model we examined the univariate and bivariate relationship between the outcome

variable and each potential covariate. Any covariates associated with the outcome variable at the 0.2 level or higher were included in the analyses (Hosmer, Lemeshow, Sturdivant, 2013). The covariates included in the model were: marital status, income, sex, age, education, and ethnicity.

**Research Question 1:** *Is the dose response relationship between alcohol and injury risk significantly different for males and females?*

To test the first research question, we first conducted a case-control analyses in which we tested a model with an interaction term between sex and alcohol use (Table 1). The reference group for the odds ratio estimates was the zero drinks category. The overall model was significant,  $X^2 = 102.08, p < .01$ . Both level of alcohol use ( $X^2 = 36.93, p < .01$ ), and being male, ( $X^2 = 14.58, p < .01$ ) were associated with significantly increased injury risk. The individual tests for each drink category indicated all drinking categories were significant, such that even consuming one alcoholic beverage in the 6-hour period prior to the injury increased one's risk for injury. The interaction term between sex and alcohol was not significant, ( $X^2 = 7.21, p = .13$ ), indicating that the slope of the risk relationship between alcohol and injury did not differ significantly between males and females.

**Table 1 Case-control unadjusted model**

Parameter	Relative Risk	95% CI		<i>p</i>
1 drink	1.91	1.05	3.46	.03
2-3 drinks	2.75	1.72	4.41	< .01
4-5 drinks	3.43	1.79	6.27	< .01
6+ drinks	3.97	1.82	4.65	< .01
Sex	1.61	1.25	2.08	< .01
Alcohol*Sex	.68	.43	1.08	.86

We re-ran the model with education, age, marital status, ethnicity, and income as controls (Table 2). The overall adjusted model remained significant, ( $X^2 = 134.51, p < .01$ ). Alcohol

use, ( $X^2 = 50.77, p < .01$ ) and being male, ( $X^2 = 14.53, p < .01$ ) both stayed significantly associated with increased risk of injury. Additionally, being younger in age ( $X^2 = 18.10, p < .01$ ) was also associated with increased risk of injury. None of the other covariates showed significance. The interaction term between alcohol use and sex remained non-significant, ( $X^2 = 5.85, p = .21$ ), again indicating no gender difference in the risk relationship between alcohol and injury.

**Table 2 Case-control adjusted model**

Case-Control Adjusted Model				
<u>Parameter</u>	<u>Relative Risk</u>	<u>95% CI</u>		<u>p</u>
1 drink	1.58	.65	3.89	.32
2-3 drinks	2.93	1.54	5.55	<.01
4-5 drinks	2.97	1.56	5.64	<.01
6+ drinks	3.44	2.26	5.24	<.01
Sex	1.67	1.23	2.17	<.01
Alcohol*Sex	.87	.71	1.06	.16
Age	.98	.97	.99	<.01

Adjusted for age, education, ethnicity, marital status and income

The non-significant interaction term indicates there is no difference in the dose response relationship between alcohol use and injury risk for males and females; however, sex was a significant independent predictor of injury such that males were overall at a higher risk of injury than females. Due to the differences in injury risk for males and females we re-ran the original model separately for males and females in order to get separate risk estimates for both groups (Table 3). For males all drink categories were significant except for one drink, where as with women all categories were significant except for 4-5 drinks.

**Table 3 Case-control adjusted model by gender**

Parameter	Males			Females		
	Odds Ratio	95% CI	<i>p</i>	Odds Ratio	95% CI	<i>p</i>
1 drink	1.47	.61 3.70	.38	2.40	1.01 5.92	.04
2-3 drinks	3.12	1.64 5.95	<.01	2.17	1.02 4.68	.04
4-5 drinks	9.81	3.32 28.96	<.01	1.83	.76 4.39	.19
6+ drinks	3.49	1.46 8.33	<.01	3.75	2.27 6.20	<.01

Adjusted for age, education, ethnicity, marital status and income

Next we ran the case-crossover analyses in which participants are used as their own controls by comparing data for the injury event with exactly the same time one week earlier. The model was first run with males and females together and then analyses were conducted for males and females separately in order to get risk estimates for both groups (Table 4). The overall model with both males and females explained a significant amount of variance in injury risk, ( $X^2 = 62.57, p < .01$ ), and, as well, reporting alcohol use in the previous 6-hours was associated with a significant increase in injury risk, ( $X^2 = 45.95, p < .01$ ). Similarly, the separate models for males, ( $X^2 = 21.13, p < .01$ ) and females, ( $X^2 = 41.62, p < .01$ ), both explained a significant amount of variance in injury risk, and, reporting alcohol use in the previous 6-hours was associated with a significant increase in injury risk among both males, ( $X^2 = 16.18, p < .01$ ), and females, ( $X^2 = 29.99, p < .01$ ).

**Table 4 Case-crossover for alcohol on injury risk**

Parameter	All Participants				Males			Females			
	Hazard Ratio	95% CI	<i>p</i>		Hazard Ratio	95% CI	<i>p</i>	Hazard Ratio	95% CI	<i>p</i>	
1 drink	3.90	1.62 9.36	<.01		3.70	.99 13.92	<.01	4.43	1.33 14.81	.01	
2-3 drinks	2.72	1.49 4.96	<.01		3.79	1.52 9.43	<.01	1.97	.87 4.48	.03	
4-5 drinks	3.51	1.63 7.53	<.01		3.54	1.21 10.32	<.01	3.52	1.16 10.66	<.01	
6+ drinks	7.09	3.61 13.90	<.01		7.67	1.55 37.95	.01	6.61	3.14 13.91	<.01	

**Research Question 2:** *Does the dose response relationship between alcohol and injury risk significantly vary according to the severity of self-reported poor mental health?*

To answer the second research question, we first performed a median split on the variable MHI-5 and then performed a case-control analysis using a model with alcohol use, MHI-5, and an interaction term between mental health and alcohol use (Table 5). The unadjusted overall model was significant ( $X^2 = 102.43, p < .01$ ). Furthermore, the analysis of effects indicated that score on the MHI-5, ( $X^2 = 4.27, p < .05$ ), alcohol use, ( $X^2 = 28.93, p < .01$ ), and the interaction ( $X^2 = 9.31, p < .05$ ), all were significantly associated with increase risk for injury. The adjusted model showed similar effects; the overall model remained significant, ( $X^2 = 122.61, p < .01$ ), and alcohol use, ( $X^2 = 24.34, p < .01$ ), and the interaction term, ( $X^2 = 9.53, p < .05$ ), both remained significantly associated with increased risk for injury. However MHI-5 was no longer significant at the .05 level, ( $X^2 = 2.57, p = .08$ ), indicating the self-report of negative mental health symptoms was not associated with increased risk of injury on its own. Furthermore, in the adjusted model both sex, ( $X^2 = 9.00, p < .01$ ), and marital status, ( $X^2 = 6.73, p < .05$ ), were also significant, indicating that being male still increases one's risk for injury and being married or in a common-law relationship reduces one's risk. The significant interaction term indicates that mental health is partially moderating the association between alcohol use and injury, such that there is a greater risk for injury among individuals who consumed alcohol and reported mental health symptoms relative to those reporting fewer mental health symptoms.

**Table 5 Case-control for alcohol and mental health on injury**

Parameter	Unadjusted Model			Adjusted model*		
	Relative Risk	95% CI	<i>p</i>	Relative Risk	95% CI	<i>p</i>
Alcohol	1.50	1.29 1.73	<.01	1.43	1.23 1.67	<.01
MHI-5	1.37	1.03 1.81	.03	1.29	.97 1.73	.08
MHI-5*Alcohol	1.36	1.06 1.75	<.01	1.35	1.04 1.73	.02
Sex	-	- -	-	1.82	.72 .94	<.01
Marital Status	-	- -	-	.67	.49 .91	<.01

\*adjusted for ethnicity, education, marital status, and income

**Research Question 3:** *Is the relationship between alcohol, mental health, and injury risk significantly different for males and females?*

To answer the final research question, we first ran a one-way ANOVA to determine whether males and females differed on scores on the MHI-5. The test was not significant,  $F(2, 93) = 1.58, p = .21$ , with males scoring an average of 19.52 ( $SD = 5.59$ ) and females scoring a mean of 18.96 ( $SD = 5.28$ ). Next, we tested a model with an interaction term between sex and mental health symptoms. The overall unadjusted model explained a significant amount of the variance in injury risk, ( $X^2 = 120.86, p < .01$ ), as well, alcohol use, ( $X^2 = 76.06, p < .01$ ), and total score on the MHI-5, ( $X^2 = 4.09, p < .05$ ) were significantly associated with increased risk for injury. The interaction term between sex and mental health was not significant, ( $X^2 = 2.38, p = .12$ ), indicating that there was no difference between males and females in the relationship between mental health and injury. The adjusted model was also significant, ( $X^2 = 136.43, p < .01$ ). Alcohol use and total score on the MHI-5 remained significantly associated with increased risk of injury, while the interaction remained nonsignificant. Marital status also showed significance, indicating that being married or common-law reduced one's risk of injury. Next, to test whether there was a gender effect in the interaction between mental health and alcohol use on injury risk we used the median split and tested for a sex by alcohol interaction for risk of injury among



participants with low levels and high levels of mental health symptoms. Among participations with low levels of mental health symptoms, being male, ( $X^2 = 3.79, p = .05$ ), and alcohol use, ( $X^2 = 10.73, p < .01$ ), were both significantly associated with increased risk for injury. The sex by alcohol interaction was not, ( $X^2 = .48, p = .48$ ), denoting that among participants self-reporting low mental health symptoms there is no gender difference in the slope of the risk relationship between alcohol and injury. Among participants reporting high levels of mental health symptoms being male, ( $X^2 = 9.61, p < .01$ ), and alcohol use, ( $X^2 = 19.09, p < .01$ ) were still associated with increased risk of injury. Furthermore, the interaction term, ( $X^2 = 3.31, p = .06$ ) neared significance but remained non-significant at an alpha of .05. To determine whether this lack of significance was due to a lack of power we recoded the alcohol variable from four categories to 3 categories (0 drinks, 1-2 drinks, 3-4 drinks, and 5+ drinks). We first tested to ensure no significant gender differences in mean number of drinks in each drink category, then we reran the adjusted model with the newly coded alcohol variable (Table 6). Among the participants with low mental health symptoms the results remained the same; alcohol use, ( $X^2 = 10.33, p < .01$ ), and being male, ( $X^2 = 3.70, p = .05$ ), were associated with increased risk of injury. The interaction term was not significant, ( $X^2 = .56, p = .45$ ) indicating no gender differences in the risk relationship between alcohol and injury among participants who had self-reported low mental health symptoms. In contrast, among those participants who had self-reported high levels of mental health symptoms, being male, ( $X^2 = 10.78, p < .01$ ), and alcohol use, ( $X^2 = 16.69, p < .01$ ) still were significantly associated with increased injury risk. Additionally, the interaction term was also significant, ( $X^2 = 5.09, p < .05$ ), revealing a significant gender difference in the slope of the risk relationship between alcohol use and injury.

**Table 6 Adjusted model for mental and alcohol on injury**

Parameter	Low Mental Health Symptoms			High Mental Health Symptoms				
	Relative Risk	95% CI	<i>p</i>	Relative Risk	95% CI	<i>p</i>		
Alcohol	1.59	1.22	2.07	<.01	2.64	1.66	4.20	<.01
Sex	1.53	1.01	2.32	.05	1.20	1.32	3.02	<.01
Alcohol*Sex	.87	.62	1.20	.40	.56	.34	.93	.02

Adjusted for age, ethnicity, marriage, education, and income

The significant interaction term indicates that there is a gender difference in the relationship between mental health and alcohol use on injury. More specifically, among participants who self-reported high levels of mental health symptoms, the slope of the risk relationship between alcohol and injury is greater for females. In order to gain a better understanding of this complex relationship we reran the analyses for men and women separately (Table 7). The overall adjusted models for females, ( $X^2 = 49.25, p < .01$ ), and males, ( $X^2 = 72.81, p < .01$ ), were both accounted for a significant amount of variance in injury risk. In the model for females, the analysis of effects indicated that alcohol use, ( $X^2 = 17.88, p < .01$ ) was associated with a significant increase in injury risk. The interaction between alcohol and the MHI-5, ( $X^2 = 7.11, p < .01$ ), was also significant, denoting a synergistic effect between alcohol and mental health symptoms on injury risk. The MHI-5, ( $X^2 = .05, p = .83$ ), was not associated with injury on its own and all other covariates were also not significant. On the other hand, the analysis of effects for males indicated that alcohol use, ( $X^2 = 10.55, p < .01$ ), and total score on the MHI-5, ( $X^2 = 4.20, p < .01$ ), was significantly associated with increased risk for injury; however the interaction between alcohol and mental health was not significant, ( $X^2 = 1.91, p = .17$ ), implying a lack of synergistic effect between mental health and alcohol use for injury risk. Additionally, there were no significant covariates in the female model, but marital status was significant for

males, ( $X^2 = 12.08, p < .01$ ), indicating being married or in a common law relationship was protective against injury.

**Table 7 Adjusted model for mental health and alcohol on injury by gender**

Parameter	Males				Females			
	Relative Risk	95% CI		<i>p</i>	Relative Risk	95% CI		<i>p</i>
Alcohol	1.29	1.11	1.50	<.01	1.42	1.16	1.74	<.01
MHI-5	1.57	1.01	2.33	.04	1.06	.69	1.63	.83
Alcohol* MHI-5	1.22	.96	1.54	.10	1.66	1.10	2.51	<.01

Adjusted for age, ethnicity, marital status, education, and income

## Discussion

The aim of the current study was to test the following three research questions:

1. Is the dose response relationship between alcohol and injury risk significantly different for males and females?
2. Does the dose response relationship between alcohol and injury risk significantly vary according to the severity of self-reported poor mental health symptoms?
3. Is the relationship between alcohol, mental health, and injury risk significantly different for males and females?

For the first research question we hypothesized that the risk relationship would be greater for females compared to males; this hypothesis was not supported. While sex was a significant independent predictor of injury, such that men were at a greater risk of injury, we found no differences between men and women in the dose response relationship between alcohol and injury risk. In other words, our results indicate that when men and women consume relatively the same amounts of alcohol they are both equally at risk of injury. These findings are not entirely without precedent, as previous literature reveals mixed findings regarding gender differences. For example, other ED studies have reported a greater risk of injury for females at most levels of reported alcohol consumption (Gruenewald, Johnson, Ponicki, & Lascaia, 2010; Mcleod et al., 1999; Stockwell et al., 2002; Watts et al., 2007), while other studies report no gender differences (Ashley et al., 1994). One possible explanation given for the mixed findings in the literature regarding gender differences is study design; ED studies using participants as their own controls have reported no significant gender differences, where as ED studies using general population as

quasi-controls do report gender differences (Stockwell & Greer, 2009; Stockwell et al., 2002; Watt et al., 2004; Wells et al., 2007). There are pros and cons to using either method; the case-control design allows one to compare the differences between injured and non-injured patients, thereby allowing one to potentially isolate risk factors for injury. However, non-injured ED attendees may not be good controls as they are more likely to be drinking heavily or abstaining compared to the source population (Cherpitel, 1993). The case-crossover design allows one to use the injured individuals as their own controls, thereby reducing confounding variables due to stable within-person risk factors. However, this approach is also vulnerable to recall bias, and may result in inflated risk estimates (Gmel & Daeppen, 2007; Ye et al., 2010). The present study compared the case-control and case-cross over approach and both analyses revealed similar findings of no apparent gender differences between alcohol use and injury risk. Given that both analyses produced similar results, it is possible that our findings do in fact reflect a lack of gender difference in our sample; however, there are also other study design variables to consider. For example, one research study reported that women are more likely to underreport their alcohol consumption when they are feeling guilty about their drinking (Ely, Hardy, Longford, & Wadsworth, n.d.). If coming to the ED for an alcohol-related injury produced feelings of guilt, women may have been more likely to underreport their alcohol consumption relative to men, thereby washing out potential gender differences in the dose response relationship between alcohol and injury. Another possible explanation for the lack of significant gender differences is the lack of knowledge regarding the rate in which the alcohol was consumed during the 6-hour period. If we were to compare two individuals who reported consuming six drinks prior to their injury, but one individual consumed a single drink every hour

while the other consumed all six drinks in the last hour, their blood alcohol level would be quite different. In this instance, it makes it more difficult to compare injury risk based on quantity of alcohol consumed. Perhaps for future research more information could be collected regarding rate of alcohol consumption; or, the 6-hour period could be reduced to a short time frame in order to control for these potential confounding variables.

Additionally, since the males in our sample were already at a higher risk of injury, it may have washed out the gender effect. Finally, some research has indicated the females may be more at risk when specifically looking at violence-related injuries (Wells et al., 2007). The present study examined the risk for all types of injury; however, if we were to look only at violence-related injuries a gender effect may be revealed. Further research examining the risk relationship for alcohol and different types of injuries is needed to explore whether gender differences are apparent only with certain types of injuries.

We also find it worth mentioning that these mixed findings may be, in part, due to the way in which the alcohol use variable was coded. Originally, we ran the analyses with the number of drinks variable coded as 3 categories (0, 1-3, 4-6, and 7 or more). With this variable there was a significant sex by alcohol interaction; however the mean level of drinks within each category was also different for males and females with men consistently having a higher mean. When we recoded the number of drinks variable into the 4 categories we used for the present analysis (0, 1, 2-3, 4-5, 6 or more), this interaction effect disappeared. This finding suggests a cautionary note for future research to pay careful consideration to the way in which the alcohol variable is treated when testing for gender differences.

The slope of the dose-response relationship between alcohol and injury also warrants some discussion. While the case-control approach with all participants revealed a linear association between amount of alcohol consumed and risk for injury, when examining the odds ratios for males and females separately there was a less linear pattern. In particular, among men the highest risk injury was for those consuming between 4-5 drinks. With regards to the high-risk estimate for men consuming 4-5 drinks relative to 6 or more drinks, this finding may be explained by previous literature comparing moderate drinkers to heavy drinkers. For example, one study found that regular heavy drinkers were at a higher risk of injury leading to hospitalization only when they were alcohol-negative. In contrast, non-heavy drinkers have a higher risk of injury when alcohol-positive (Miller & Spicer, 2012). This may be due to the fact that heavy drinkers have developed a tolerance to the effects of alcohol and as such, are less likely to be injured because they are less affected by the alcohol. Additionally, it may be the case that individuals in the six or more drinks category have consumed so much alcohol that they were incapable of placing themselves in situations in which an injury could have occurred (Cherpitel, 2011). The current study did not measure usual pattern of drinking, therefore we could not control for this in the analysis. Future research including this information would be helpful in better understanding the relationship between alcohol use and injury risk among different types of drinkers.

In contrast to this, in the case-control design the 4-5 drink category was not significant among women, and consuming 6 or more drinks was associated with the greatest risk for injury. This particular finding may be due to a power issue, as the case-crossover analysis with all participants indicated a much more linear pattern; however, it

may also be worth exploring how different doses of alcohol are associated with injury risk in such a non-linear pattern among women. A possible explanation for our findings is that women in this category were consuming alcohol at a slower rate than women in other categories, thereby resulting in a lower BAC level and placing them at a lower risk for injury. Another possible explanation is that women consuming between four and five drinks were cognizant enough to experience feelings of guilt so they may have under-reported their alcohol consumption, thereby artificially placing them in the 1 or 2-3 drinks category. On the other hand, women consuming over 6 drinks may have been intoxicated so as to not feel guilty, thereby reporting their actual amount or slightly more than their actual amount.

The results of the case-crossover analysis revealed a similar non-linear pattern; with all participants showing a higher risk for 1 drink relative to 2-3 drinks and 4-5 drinks. While the model for men indicated a linear pattern, the model for women revealed a lower risk for 2-3 drinks relative to 1 drink. These non-linear findings are particularly unexpected, as most research supports a pattern of increased risk of injury with increasing levels of alcohol consumption (Cherpitel, 2007; Macdonald et al., 2005; Stockwell et al., 2002). Such an unexpected non-linear pattern may be attributed to a power issue, as the different groups were relatively small in the case-control analysis, especially once the analysis was done separately for men and women. When looking at the 95% confidence intervals for some of the drinking categories, there is quite a big spread, and there is overlap in the confidence intervals between categories. The wide spread in the confidence intervals suggests that there was some difficulty in determining the hazard ratios and the results should be interpreted with a little more caution.



These results may also be due to a potential bias that has been found in case-crossover analyses. One particular study found that when asking participants to recall their alcohol consumption there was a recall bias, which was larger among less-frequent drinkers (Ye, Bond, Cherpitel, Stockwell, & Bond, 2013). Therefore, individuals who typically consume less alcohol have a more difficult time recalling their alcohol use in the week prior, which could result in a bias of the results among drinkers in the lower drink categories. As this bias has been found in several case-crossover designs (Gmel & Daeppen, 2007; Ye et al., 2013), findings from case-crossover designs should be interpreted with this mind. Future research is needed to examine the discrepancies between case-crossover and case-control studies and develop methods to try and reduce these discrepancies and ameliorate the issue of recall bias.

Our second research question examined the dose response relationship between alcohol and injury risk over high and low levels of self-reported negative-mental health symptoms. We predicted that the risk relationship would be greater for individuals reporting higher levels of mental health symptoms and this hypothesis was supported. The results indicated a synergistic effect between mental health and alcohol, such that the risk for injury was greatest among those consuming higher levels of alcohol and reporting higher levels of poor mental health relative to those only consuming alcohol and those reporting fewer mental health symptoms. Such an effect between mental health and alcohol suggests that there may be a particular group of individuals, those experiencing mental health symptoms and consuming alcohol, who are at a greater risk for injury. These findings are supported by previous literature that supports a link between negative mental health symptoms and heavier alcohol consumption (Dawson et al., 2005; Geisner et al., 2012;

Weitzman, 2004) and a link between alcohol consumption and higher risk of injury (Cherpitel, 2007; Rhem et al., 2009; Rhem et al., 2004). While our results indicated a relationship between alcohol and mental health on injury, we were unable to determine the direction of causality in this relationship. Previous research suggests a bi-directional relationship between mental health and alcohol use. For example, individuals may consume alcohol to cope with the negative affect or mental health problems (Kushner et al., 1996), while other research has indicated that substance use can cause some forms of mental illness (Schuckit & Hesselbrock, 1996). Additionally, there may be a cyclical relationship in which alcohol leads to depressive symptoms, or visa versa, and both the alcohol use and the symptoms feedback into each other over time resulting in an increase in both (Hussong, Hicks, Levy, & Curran, 2001).

The nature of this relationship may be explained by previous research examining the link between mental health, alcohol use, and injury risk, which has implicated impulsivity as a possible underlying explanatory factor. Impulsivity has been consistently found to be a risk for alcohol use; individuals who are more impulsive tend to consume more alcohol and experience more alcohol-related problems than nonimpulsive individuals (Dick et al., 2010; Marcziński, Abrams, Van Selst, & Fillmore, 2005). Reports of negative mood and problematic behavior have also been found to be higher among more impulsive individuals (Karyadi & King, 2011; King, Karyadia, Luk, & Patock-Peckham, 2011). Moreover, depression and impulsivity have a higher likelihood of co-occurrence among individuals with substance use disorders (Jakubczyk et al., 2012).

Previous research specifically examining how affect, alcohol, and injury are related provides support for the contributing role of impulsivity. For example, in a study examining

suicide proneness among college students with depressive symptoms, the relationship between suicide proneness and depression was moderated by interactions of alcohol use and factors of impulsivity (Dvorak, Lamis, & Malone, 2013). Another study looking at how impulsivity interacted with depressive symptoms and alcohol use found that impulsivity enhanced the risk association between depression and alcohol problems. In other words, individuals with depression scoring higher in impulsivity were not only more likely to drink, but were also more likely to experience alcohol problems (King et al., 2011). Finally, a study examining the link between alcohol, depression, and conduct problems on violence related injuries among patients at a Mexican ED reported that patients who had consumed alcohol within the six hours prior to being admitted to the ED were more likely to have a violence-related injury relative those who had not had any alcohol in the previous six hours. Depressive symptoms were also associated with a violence related injury, while alcohol dependence and conduct problem behaviors were not (Borges et al., 2004).

Some researchers have argued that impulsivity or decreased restraint is a state that tends to be more common among individuals experiencing depression (Corruble, Benyamina, & Bayle, Falissard, & Hardy, 2003; Swann, Steingberg, Lijffijt, & Moeller, 2009), which may in turn result in more risk-taking behaviors. More specifically, depressive symptoms have been associated with particular aspects of impulsivity called non-planning impulsivity or an inability to delay reward-related responses (Swan, Bjork, Moeller, & Dougherty, 2002), and negative urgency (Cyders & Coskunpinar, 2010). Non-planning impulsivity is consistent with the sense of hopelessness or lack of sense for the future that is commonly seen in depressed individuals (Patton, Stanford, & Barratt, 1995; Swann et al., 2008), and negative urgency is a state-specific impulsivity aspect in which individuals have

difficulty controlling their behavioral impulses when they are experiencing negative emotions (Cyders & Coskunpinar 2010). Considered together, these results suggest that the co-occurrence of depressive symptoms and impulsivity may lead to more increased alcohol consumption and increased risk taking behaviors among individuals consuming alcohol.

As impulsivity has also been associated with positive affect (Wray, Simons, Dvorak, Gaher, 2012), some studies have compared positive and negative affect to determine whether the outcomes may differ. For example, a study specifically looking at how affect and impulsivity contribute to drinking behaviors found that individuals higher in positive affect consumed more alcohol, but there was no direct relationship between positive affect and alcohol problems. In contrast, individuals with high levels of negative affect had a tendency to engage in rash behaviors and this was associated with increased engagement in alcohol-related risk behaviors. Therefore, when individuals high in negative urgency experienced negative affect, they were more likely to engage in risky behaviors such as drunk driving and fighting relative to when they were not experiencing negative affect (Wray et al., 2012). This finding was consistent with other research that suggests that individuals reporting higher levels of negative affect also tend to have disrupted behavioral control. Negative affect and difficulty inhibiting behaviors coupled together results in individuals consuming more alcohol than what their typical use would be and engaging in riskier behaviors while under the influence of alcohol (Simons et al., 2005). Another study examining the relationships between affect and alcohol use among college students reported similar results. Both negative and positive affect during the day correlated with higher levels of alcohol consumption at night; however, only negative affect was associated with alcohol-related problems. Impulsivity was also found to be associated with higher

alcohol consumption and alcohol-related problems. Moreover, impulsivity moderated the relationships between negative affect and alcohol-related problems (Simons et al., 2005). These results have been replicated in populations of adolescents as well. Colder and Chassin (1997) reported that adolescents who were rated higher on impulsivity and low on levels of positive affect had higher levels of alcohol use and impairment relative to their nonimpulsive peers as well as impulsive adolescents with high positive affect. Again, an interaction between negative affect and impulsiveness is shown to create additive risk factors for alcohol consumption, risky drinking behaviors, and experiencing alcohol-related problems. Higher levels of alcohol consumption and more engagement in risky behaviors also increase the risk of injury. Given these results, it is possible that individuals experiencing negative affect who also consume alcohol are at a higher risk of being injured either intentionally or unintentionally. However, further research is needed that specifically examines the relationship between affect, alcohol consumption and risk of injury in order to tease apart the complexity of this relationship.

Finally, the third research question examined whether the relationship between alcohol, mental health, and injury risk was significantly different for males and females. We hypothesized that females would be at greater risk and this too was supported. While the results indicated that there was no interaction between mental health and gender in predicting injury, they did reveal that the synergistic effect of mental health and alcohol use was stronger for females relative to males. The nonsignificant interaction between mental health and gender signifies that there were no gender differences in the risk relationship between mental health and injury. In other words, men and women experiencing similar levels of mental symptoms were at equal risk for injury. When the analyses were conducted

separately for men and women some other interesting patterns emerged. Among males, both alcohol and mental health symptoms independently predicted injury; however there was no interaction between alcohol and mental health. In contrast, among females alcohol predicted injury, while mental health on it's own did not. Furthermore, the interaction between alcohol and mental was significant only among females. These results indicate that men reporting high levels of mental health symptoms with no alcohol consumption, or, higher levels of alcohol consumption and low levels of mental health symptoms may be at greater risk for injury compared to when both alcohol use and high levels of mental health symptoms are present. In contrast, women reporting high levels of mental health problems and alcohol consumption simultaneously are at a much higher risk for injury relative to women reporting only high levels of mental symptoms or alcohol use. These results mirror some of the previous findings examining mental health and alcohol use; some research has indicated that women may be more likely to consume alcohol as a coping mechanism following negative mood states (Hussong, 2007; Zucker, 1986). Therefore, it is possible that the women in the study experiencing negative mood states were more likely to consume alcohol, thereby increasing their risk for injury. In contrast, men are more likely drink for enhancement motives (Cooper et al., 1992; Kuntsche et al., 2005), which is less likely to be associated with negative mental health symptoms. The finding that mental health symptoms were not a significant independent predictor for injury among females was more surprising. While most research on mental health and injury risk do not report gender differences, some research has indicated that the association between depressive symptoms and injury is stronger among females (Forsen et al., 1999; Nordstrom et al., 2001; Whooley et al., 1999). It is possible that this finding may be a result of a lack of power

in the analysis; however, it is also plausible that these results suggest a particular subgroup of females who are at an increased risk of injury. In particular, females who are experiencing negative mental health symptoms and consuming alcohol are at a much higher risk for injury relative to women not experiencing negative mental health symptoms.

Similar to the findings regarding mental health and alcohol use, these gender differences could also be explained by the underlying factor of impulsivity. Some research has indicated that impulsivity is a stronger predictor for substance use among females compared to males (Grano, Virtanen, Vahtera, Elovainio, & Kivimaki, 2004). Additionally, one study reported that the link between impulsivity and alcohol use was found only among women (Fu et al., 2007). Within the context of this study, it is possible that impulsivity may explain the link between mental health and alcohol use on injury risk for women. However, other studies have reported mixed findings regarding gender differences in the association between impulsivity and alcohol use, with some reporting no gender differences (Grano et al., 2004), and some reporting a stronger association among males (Baker & Yardley, 2002). Future research is needed to tease apart this complex association and examine impulsivity as a potential underlying factor that could help explain the pathway between poor mental health, alcohol use, and injury risk.

While the present study contributes to the limited knowledge base on the intersections of mental health, alcohol use, and gender on injury risk, it is not without limitations. First, some of the analyses examining two and three way interactions may have had limited power. Although our overall sample size was quite large, our sample of injured patients was relatively small when trying to examine several variables simultaneously. In

particular, some of the results regarding gender differences were unexpected and partially inconsistent with previous literature. Future research would be helpful in trying to replicate these results with a larger sample size.

Another limitation to our small sample size was that we were unable to examine other types of substances, or compare violence versus non violence-related injuries. Understanding how different substances could contribute to injury would be useful in understanding the independent effects of alcohol as well as other potential substance related risk factors for injury. Moreover, gaining a better understanding of how mental health may predict violence versus non-violence related injuries could have both clinical and practical implications.

Additionally, as data was only collected on Friday and Saturday nights our sample may not be representative of the general population, or of individuals who are admitted to the ED. Given this limitation, it would be difficult to provide a prevalence estimate of individuals coming to the ED for injuries relative to non-injuries. However, the current study was designed to examine differences within the data, not to provide prevalence estimates. In such a case, it is more imperative that there is a sufficient sample size in each analyses and the days on which the data was collected does not act as a limitation to the present study.

There are also some potential limitations regarding our use of the alcohol variable. There is some debate in the literature regarding the way in which alcohol use variables should be treated, as categorical and continuous variables may yield different results. Our results differed depending on the categories we used, which suggests that future research is needed in determining the most accurate method in analyzing alcohol use. Furthermore,



we collected data on alcohol use for the 6-hour period prior to injury or illness event. A 6-hour period is quite a large time gap and there could be significant differences on the effects of alcohol depending on the rates in which individuals were drinking. An alternative to using amount of alcohol consumed is to use a measure of BAC; however, this would have to be taken at the time of the interview. The difficulty in this is that this would be a measure of blood alcohol level at the time of the interview, not at the time of the event, and individuals may wait several hours before deciding to come to the ED. To reiterate, future research examining the best method for analyzing alcohol use is needed to gain a clearer picture of the relationship between alcohol consumption and injury. Increased knowledge on this may help to solve some of the mixed findings regarding gender differences. Moreover, a gold standard for measuring and coding alcohol use could streamline future research so that a similar variable is used across studies, which would facilitate comparisons between studies. Regardless, the current study demonstrates the difficulty in analyzing this type of data and perhaps sheds some light on the current inconsistencies in the literature.

Finally, there is a potential limitation with the MHI-5. As we are collecting data with people while they may be experiencing a stressful or negative event, their mood state at the time of the interview may bias their responses to the items on the scale. For example, individuals may be less likely to endorse the items that have felt happy or calm most of the time in the past 30 days. However, the MHI-5 is a subscale of the SF-36, which was developed to assess patient functioning in medical settings. The MHI-5 has been shown to have good reliability and good criterion validity when used as a screening tool for overall

psychological well-being and various mood and anxiety disorders (Berwick et al., 1991; Stewart et al., 1988).

In summary, the findings from the present study provide further support for the strong association between alcohol use and injury risk. The present study also illuminates the difficulties in this type of research, particularly regarding the treatment of the alcohol use variable. Nonetheless, our findings suggest that while men are overall at a higher risk for injury, the dose response relationship between alcohol use and injury may not significantly differ for males and females. The present study also contributes to the limited knowledge base on the role of gender and mental health in the association between alcohol use and injury. Mental health symptoms are a significant independent predictor for injury, particularly among males. This finding is interesting as unlike many demographic and situational variables, mental health symptoms are a risk factor for injury in addition to alcohol use. Additionally, there is a synergistic effect between mental health and alcohol among females, such that women who are experiencing higher levels of negative mental health symptoms and consuming alcohol are at a much higher risk for injury. The results suggest that there may be particular groups of individuals who are a greater risk of injury. More specifically, women experiencing mental health symptoms and consuming alcohol and men experiencing mental health symptoms or men and women consuming alcohol, were at a higher risk of injury.

While future research is still needed to further elucidate the complex relationship between mental health, alcohol, and gender on injury risk the present findings have both clinical and practical implications. Understanding how negative mental health symptoms are contributing to increased risk of injury may be useful in informing health professionals

in the medical setting. It may be beneficial to use a scale such as the MHI-5 to quickly assess a patient's psychological well-being while they are being treated in the ED. The awareness of potential depressive or anxiety symptoms could lead to better treatment, and perhaps reduce the likelihood of injury recidivism. It is also possible that the treatment of the mental health symptoms may help to reduce alcohol consumption if the individual is using alcohol as a coping mechanism. Additionally, this information can be used to better inform the public regarding the risks of alcohol, particularly among those experiencing negative mental health symptoms. Furthermore, the gender difference in the relationship between mental health and alcohol on injury indicates that the reason or cause of injury may be different for men and women. This suggests that gender-specific intervention and prevention practices may be more effective than a single overarching strategy. Finally, information on the impact of mental health and alcohol use on injury risk can be used to inform policy makers and influence public health policies regarding injury prevention.

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## Appendix

### Appendix A. Description of measures used

#### Mental Health Inventory – 5 Items (MHI-5)

The Mental Health Inventory is a five-item mental health subscale from the Medical Outcomes Study Short Form Health Survey (SF-36). The SF-36 was designed to assess patient functioning in medical settings. The MHI-5 was designed to assess mental health functioning with the previous month, including overall psychological well-being and symptoms of anxiety and depression.

Items:

1. During the last month, how much of the time have you been a very nervous person?
2. During the last month, how much of the time have you felt calm and peaceful?
3. During the last month, how much of the time have you felt downhearted and blue?
4. During the last month, how much of the time have you been a happy person?
5. During the last month, how much of the time have you felt so down in the dumps that nothing could cheer you up?
  - All of the time
  - Most of the time
  - A good bit of the time
  - Some of the time
  - A little of the time
  - None of the time

#### Scoring and Interpretation Procedures

1. All items are scored so that higher scores reflect better mental health:
  - Items 1, 3, and 5 are scored from 0 = all of the time to 5 = none of the time
  - Items 2 and 4 are scored from 5 = all of the time to 0 = none of the time
2. Both sub-scores and a total score can be computed:
  - MHI-5 Anxiety
    - Item 1 (range from 0 = high anxiety to 5 = low anxiety)

- MHI-5 General Positive Affect
  - Item 2 + Item 4 (range from 0 = low positive affect to 10 = high positive affect)
- MHI-5 Depression
  - Item 3 (range from 0 = high depression to 5 = low depression)
- MHI-5 Behavioural/emotional control
  - Item 5 (range from 0 = low control to 5 = high control)
- MHI-5 Total Score
  - All items summed (range from 0 = poor overall mental health to 25 = good overall mental health)

## Alcohol Use Disorders Identification Test (AUDIT)

### AUDIT

**PATIENT:** Because alcohol use can affect your health and can interfere with certain medications and treatments, it is important that we ask some questions about your use of alcohol. Your answers will remain confidential, so please be honest.

For each question in the chart below, place an X in one box that best describes your answer.

**NOTE:** In the U.S., a single drink serving contains about 14 grams of ethanol or “pure” alcohol. Although the drinks below are different sizes, each one contains the same amount of pure alcohol and counts as a single drink:



Questions	0	1	2	3	4	
1. How often do you have a drink containing alcohol?	Never	Monthly or less	2 to 4 times a month	2 to 3 times a week	4 or more times a week	
2. How many drinks containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 to 9	10 or more	
3. How often do you have 5 or more drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
4. How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
8. How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
9. Have you or someone else been injured because of your drinking?	No		Yes, but not in the last year		Yes, during the last year	
10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year	
					<b>Total</b>	

**Note:** This questionnaire (the AUDIT) is reprinted with permission from the World Health Organization. To reflect drink serving sizes in the United States (14g of pure alcohol), the number of drinks in question 3 was changed from 6 to 5. A free AUDIT manual with guidelines for use in primary care settings is available online at [www.who.org](http://www.who.org).