

**NON-FATAL INJURY ON DUTY AND ASSOCIATIONS WITH MENTAL HEALTH,
MALADAPTIVE COPING, AND SLEEP DISTURBANCE AMONG POLICE OFFICERS**

by

Christine Anne West

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Doctoral Committee:

Professor Siobán D. Harlow, Chair
Professor Michael E. Andrew, CDC/NIOSH, University of West Virginia
Professor C. Raymond Bingham
Associate Professor Marjorie C. McCullagh
Assistant Professor Sung Kyun Park

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DEDICATION

This dissertation is dedicated to my devoted partner, Gordon, whose faith in me gave me the confidence and time to accomplish this, and to my lovely daughters, Sydney and Ila, who also supported me along the way. I wanted to make them proud and honor their sacrifices, embarking without complaint on “our two-year adventure in Michigan” and having limited time from their mother and wife during the subsequent 2 years of dissertation research. Proof yet again that we could get through anything as long as we are together.

This is also dedicated to the men and women officers who serve and strive to make a worthwhile contribution to society and the communities in which they live and work in; including making personal sacrifices to ensure the safety and protection of others.

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ABSTRACT

Non-fatal Injury on Duty and associations with Mental Health, Maladaptive Coping, and Sleep Disturbance among Police Officers

by

Christine Anne West

Chair: Siobán D. Harlow

Background: Police work involves exposure to multiple critical incident stressors including the risk of being seriously injured or killed. The objective of the research was to examine the prevalence, frequency, duration, and recency of injury leave and the association of injury with perceived stress, mental health, substance use, and sleep quality in U.S. police officers.

Methods: The sample population for this study included all 430 active duty police officers from a mid-sized urban police department enrolled in a cohort study between 2004 and 2009. Self-reported measures of mental health and behavioral outcomes and injury leave data were available from work history data. Bivariate and multivariate regression analyses were conducted comparing mental health, behavioral, and sleep outcomes in officers with and without injury and by increasing number, length and recency of injury.

Results: Nearly two-thirds of the participants had experienced an injury. Among those injured, 67 percent experienced more than one duty-related injury with an average of 3 injuries (range 1-12). The median number of days on leave due to a duty-related injury was 86 (range of 1-2250) with 41% having had more than 90 days leave. Although trending in the hypothesized direction, mean perceived stress, depression, PTSD, anxiety scores, smoking, and alcohol use were not statistically significantly associated with injury occurrence or length of injury. Mean perceived stress, PTSD, anxiety, and cigarettes smoked increased with increasing number of injuries. Poor sleep quality mediated the effect of injury on adverse psychological outcomes after controlling for age, sex, and rank. Poor sleep quality was significantly associated with having had an injury, number of injuries, and length of injury after adjustment.

Conclusion: Findings suggest work-related injury is common and repeated work-related injuries are psychologically distressing and associated with poor sleep quality in U.S. police officers. Targeted and timely clinical and workplace interventions to prevent injuries, improve sleep quality, and psychological symptom development are needed. Future longitudinal studies should examine these outcomes with more injury-specific information, with other first responder groups, and in nationally representative datasets.

CHAPTER 1

Introduction

Overview

First responders—police, firefighters, search and rescue personnel, and emergency medical service (EMS) providers are those individuals who serve a critical role in protecting the community against threats to life, property, and the environment. First responders are asked to put their own lives and well-being at risk in order to protect the life and property of ordinary citizens. As a result, they face injury and fatality rates that are higher than those faced by workers in non-responder occupations. There is considerable interest by government and private agencies to identify and prevent adverse health outcomes to first responder populations which requires a comprehensive understanding of the trends of injury and illness and their specific risk factors.

Given the hazardous work faced routinely and in special circumstances (i.e. disasters) first responders can experience many adverse health consequences (LaTourrette et al., 2008; Houser, 2004). Injuries in the line of duty are one common health threat. These injuries range in scope and severity—and can have lasting consequences manifested physically and mentally. The relationship of injury with stress and psychological consequences has not been examined in first responders in the U.S. and this study is the first to comprehensively document the impact of injury on psychological stress and related outcomes in a first responder population. This research

focuses on injury and its consequences for law enforcement personnel with the aim of improving health and safety prevention efforts in first responders.

Research Aims

The overall objective of my research was to examine associations of duty-related injury with stress, unhealthy behaviors, and mental health outcomes and their inter-relationships in police officers. The overall conceptual hypothesis was that experiencing a duty-related injury increases the risk of having stress-related symptoms and adverse mental health and behavioral outcomes.

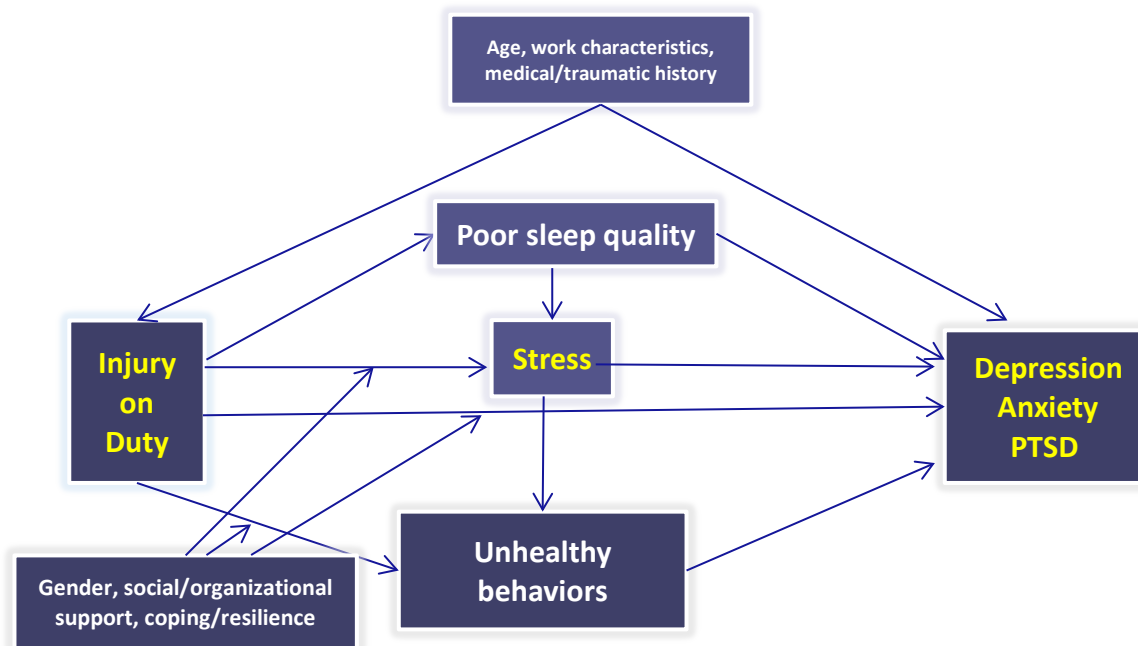
Specific research aims were as follows:

1. To determine the association between occurrence, frequency, severity, and recency of duty-related injury and perceived stress after adjusting for age, work characteristics, and gender. The extent to which these associations differ by gender, level of social / organizational support, and level of coping/resilience measures was examined.
2. To determine the association between occurrence, frequency, severity, and recency of duty-related injury and unhealthy behaviors (i.e. smoking, excess drinking, and poor sleep quality after adjusting for age, gender, and work characteristics). The extent to which these associations differed by gender and level of coping, resilience, and social support measures was examined.
3. To determine the association between occurrence, frequency, severity, and recency of duty-related injury and symptoms of depression, anxiety, and PTSD after adjusting for age, work characteristics, history of psychiatric illness, and prior trauma. The extent to which these associations differed by gender and level of coping, resilience, and social support measures and mediated by level of sleep quality was examined.

Conceptual framework

The conceptual model for this research presented in Figure 1.1.1 is based on prior research and theoretical models of stress, mental health and disability. It includes the potential direct and indirect effects of duty-related injury on the risk of PTSD, depression, and anxiety symptomology, and unhealthy behaviors in this population, conceptually informing my research aims. As suggested by previous research, an indirect effect of injury on PTSD, depression, and anxiety is proposed, characterized by the pathway that goes through the measured intermediate variable, poor sleep quality. Several factors likely confound the effect of duty-related injury and psychological symptoms. Lastly potential effect modifiers, including gender, social support, and coping and resilience, are hypothesized to be part of specific pathways from injury to stress, unhealthy behaviors, and mental health outcomes.

Figure 1.1.1: Potential casual pathways of on duty non-fatal injury and stress-related behaviors and outcomes



Public Health Significance

Identifying and defining risk factors for psychological distress resulting from traumatic and non-traumatic injury are needed and will aid in development of future prevention strategies in first responder groups. This research was undertaken in order to inform the design of injury prevention programs and to help define-optimal follow-up of post injury psychological care for first responders. Results from this study will facilitate assessment of the potential value of proactive screening of injured responders in order to quickly evaluate for stress-related outcomes. Finding the source of mental health impairments and intervening is not only important to the individuals and the families affected, but also to reduce the substantial personal and public costs associated with these outcomes.

The effect of occupational injury during routine work duties on mental health has not been well examined and this research has built on current evidence by examining the effects of injury in a high risk population. Some studies have examined the association of traumatic injury and PTSD and many have used a cross-sectional design making it difficult to assess causal ordering of injury and mental health outcomes. Most of the existing research on traumatic injury and mental health has been conducted with hospitalized populations, which limits the degree to which findings can be applied in occupational groups. To date, longitudinal studies have been short in duration following the injury event (6 months or less) while chronic outcomes may not manifest until later. Most studies have measured injury retrospectively which may result in recall and temporal bias.

Background

First responders—population characteristics and injury

First responders is a generic term referring to the first safety and medically trained responder to arrive on the scene of a life-threatening emergency, and include law enforcement, firefighters, and paramedics or Emergency Medical Service (EMS) providers. Collectively, they are also referred to as public safety workers or emergency responders. An estimated 1.5 million paid EMS, law enforcement and firefighter personnel were working in 2011, with law enforcement being the largest group (Bureau of Labor Statistics [BLS], 2012). They routinely respond to motor vehicle incidents, crimes and public disturbance, natural and man-made disasters, hazardous material spills, and building and wildland fires. Many are cross-trained to perform similar activities; for example, many firefighters and police personnel are trained and certified to perform emergency medical services as they may arrive on scene prior to paramedic crews and need to provide medical treatment. Although many of the broad occupational categories referred to as “first responders” may perform similar activities, several job tasks are unique to each responder group, and within each group considerable heterogeneity exists in the scope of activities that individuals perform and their associated work-related hazards.

In line with current demographic trends in the U.S. workforce, the first responder population is aging, with a disproportionate increase in the number of older individuals represented in these occupations (Gershon et al., 2002). Fitness declines associated with aging may occur more quickly in these high-risk jobs due to the high intensity demands and unique work-related health risks (Aldwin, 2010). Work demands for first responders differ with age;

older police officers and firefighters experience more accidents, work-related disability, sickness-related absenteeism, and mental and emotional demands than their younger counterparts (Sluiter & Frings-Dresen, 2007; Gershon et al., 2002). Many first responders are delaying retirement if feasible and working more overtime (Czaja & Sharit, 2009). In some jurisdictions, older personnel are encouraged to retire due to state and local government budget cuts and their replacement by younger workers with less experience may place them at higher risk for injury and other adverse health consequences (Nelson, 2004). The first responder population is racially diverse depending on the location but is dominated by men, especially in law enforcement where women are in the minority (Lonsway et al., 2002).

The greatest fatal injury risks facing law enforcement are due to homicides, suicides, and motor-vehicles crashes (Tiesman et al., 2010; Vena, 1986). The most common nonfatal injuries among law enforcement are attributable to assaults, transportation incidents, and training incidents mostly resulting in sprains, strains, contusions, and abrasions with many occurring more than once throughout an individual's work history (International Association of Chiefs of Police [IACP], 2012; Reichard & Jackson, 2010; LaTourrette et al., 2008; Houser, 2004). A study on the extent to which police injuries changed from 1996–1998 to 2006–2008 reported that the largest proportion of incidents occurred as a result of controlling or arresting suspects (41.0%). This category accounted for 69.6% of all incidents. The most common injuries in these incidents were bruise/black eye/contusion (30.4%), bodily fluid contact (21.7%), and human bites (15.6%). Other common injuries in suspect-related incidents were cuts/punctures/abrasions/lacerations (26.8%), sprains/ strains (24.8%), and other muscle pain (17.6%). The most common types of injuries associated with crashes were other muscle pain

(21.5%), sprain/strain (18.1%), and contact with infectious disease/bodily fluid (18.6%) (Brandl, 2012). As of 2008, public agencies are required to report illness and injury information via national surveillance systems.

In 2008 and 2011, as part of the Survey of Occupational Injuries and Illnesses (SOII), selected states reported total nonfatal injuries and illnesses for state and local government workers. The reported injury rate for police protection in local government was 13.2 injuries per 100 full-time workers in 2008 and 11.3 injuries per 100 full-time workers (FTE) (Maloney, 2014; Brown, 2011). They had the 2nd highest injury rate in local government compared to other local public workers. Using the National Electronic Injury Surveillance System for injuries treated in emergency rooms in 2000-2001, Jackson et al. (2010) compared injury rates among emergency responder groups. Overall, they found that the law enforcement injury rate was 8.5-9.2 injuries per 100 FTE, two to three times greater than that of EMS personnel and volunteer and other firefighters, but similar to injury rates for career firefighters (Reichard and Jackson 2010). According to the U.S. Bureau of Statistics (2011), protective services occupations (including police officers, correctional officers, and similar groups) had a median number of 12 days off per injury compared to seven days off in private industry (BLS, 2011). On average, nearly 90% of line-of-duty police fatalities, and 50% of lost-time injuries were assault or vehicle related (Houser, 2004). As reported from the SOII in 2008 and 2011, police and sheriff's patrol officers had among the highest percentage of injuries that required days away from work compared to other responders (Maloney, 2014; Brown, 2011).

The burden of occupational injury

The World Health Organization [WHO] estimates that injuries contribute to 12% of the world's burden of disease as measured by disability-adjusted life years and that by 2020 will account for 1 in 5 healthy life-years lost worldwide (WHO, 2008). In recent years, researchers have begun to demonstrate empirically the social and economic consequences of occupational injuries for the lives of individual workers and their families. Many physical, psychological, social, and behavioral changes occur in the aftermath of a moderate-severe occupational injury, especially with repeated injuries, even if they are less severe (Richmond & Kauder, 2000) and occurred more than one year ago (Holmes et al., 2014). An occupational injury can be thought of as a critical incident that can cause added pressure on career performance and tax an individual's emotional resources, resulting in a range of responses such as exhaustion and chronic mental health symptomology (Maguen et al., 2009; Kim, 2008; O'Donnell et al., 2004). Long-term financial hardship and disability, limited ability to perform activities of daily living, and shifts in family dynamics associated with loss of income and disability can add to the emotional and physical burdens that accompany injuries (O'Donnell et al., 2013; WHO, 2008; Strunin & Boden 2004; Dembe, 2001; Pransky et al., 2000). The occurrence of occupational injury may be especially distressing for first responders who rely on a high level of physical functioning to perform their jobs. In addition, although many first responders are able to obtain disability income, the absence of overtime pay due to disabling injury can place additional financial strain on the responders who regularly rely on overtime pay as part of their income (Senjo, 2011).

The stress reaction

Acute stress reactions are a healthy and necessary response to current life demands; the body responds to a stressor via the hypothalamic-pituitary-adrenocortical (HPA) axis and autonomic nervous system (ANS) by secreting cortisol and altering heart rate coupled with many other physiologic reactions in order to return the body to homeostasis. Little strain on the body occurs if these stressors are followed by a period of rest and recovery. However, repeated and chronic stressors lead to alterations and dysregulation of these systems that can lead to future ill health. The stress health model, first introduced by Hans Selye in 1956, is described as the general adaptation syndrome (GAS) where a nonspecific stressor results in alteration in physiological homeostasis (Selye, 1956). Three stages of GAS include the acute alarm stage, a more chronic resistance stage, and a chronic exhaustion stage in which the energy resources are exhausted and the body is unable to return to homeostasis. Allostasis is the adaptive change that leads to homeostasis and promotion of survival when stressors act upon a living organism. In what is later described by McEwen as allostatic load, a dysregulation of allostasis causing chronic overactivity or under-activity of the physiologic responses and promotion of pathophysiology (McEwen, 1993). Job stress, burnout, job insecurity, chronic pain, poor sleep, and trauma are examples of conditions that can lead to allostatic load and increased health risks due to a lack of rest and recovery where the stress response cannot shut off after the exposure (Dalal et al., 2010; Blackburn-Munro, 2001; McEwen, 1998, Sluiter et al., 1998). The job stress model is described as the harmful physical and emotional responses including illness can occur when the actual or perceived requirements of the job do not match the capabilities, resources, or needs of the worker and not effectively moderated by individuals coping ability or other protective factors in the environment (National Institute for Occupational Safety and Health [NIOSH], 1999). This is also in line with the psychosocial model of stress, introduced by

Richard Lazarus in 1984, which is an individual's perception of a specific task or stressor and evaluation in their ability to perform the task or deal with the stressor. If situational demands outweigh their perceived capacity to overcome these demands, an emotional and physiological stress reaction occurs (Lazarus, 1984).

Depression, PTSD, and anxiety

Depression is a common adverse mental health outcome that can occur after a traumatic event and is characterized by sad, anxious, and hopeless feelings, difficulty concentrating, and loss of interest in pleasurable activities (First, 2000). This condition limits an individual's energy level, concentration, decision making, and engaging in routine activities. Depressed episodes can be limited to once per lifetime but some individuals have multiple depressive episodes (National Institute of Mental Health [NIMH], 2008). The occurrence of traumatic life events has been shown to be associated with a high prevalence of depression in police officers (Hartley et al., 2007). Depression frequently co-occurs with other psychiatric problems (NIMH, 2008) where individuals who experience a traumatic event frequently develop both depression and posttraumatic stress disorder (PTSD) (Shalev et al., 1998).

According to the American Psychiatric Association (APA), Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-IV-TR), PTSD is a type of anxiety disorder that can occur following a traumatic event that causes intense fear and/or helplessness in an individual (First, 2000). The chronic form of the disorder is diagnosed at least 3 months after the event and can develop in individuals without any predisposing conditions, particularly if the stressor is extreme. A stressful event may revive memories of prior trauma and may intensify preexisting psychological or medical problems. The traumatic event can arise from critical

incidents in the life of a police officer, which can include being threatened (e.g., with a knife or gun) and direct exposure and/or injury (e.g., accidental or intentional) that occur as part of their usual work duties. Acute stress disorder (ASD) is a condition with symptoms similar to PTSD of fearfulness, avoidance, and numbing experienced in the initial month after the trauma. A significant proportion of studies indicate that approximately three-quarters of trauma survivors who initially display ASD will subsequently develop PTSD (Bryant, 2006). Other anxiety disorders, such as generalized anxiety disorder, obsessive-compulsive disorder, or social phobias cause individuals to experience extreme fearfulness and uncertainty (NIMH, 2009).

Stress and mental health of first responders

Frequent exposure to repeated stressors place first responders at risk for stress related illnesses such as psychiatric disorders, heart disease, and hypertension (Maguen et al., 2009; Hartley et al., 2007; Marmar et al., 2006; Carlier et al., 1997) with higher rates of these conditions found compared to other occupational groups (Franke et al., 1998; Vena et al., 1986). In particular, an extensive body of scientific literature has been written on work stress in law enforcement. Early evidence presented by Kroes and Hurrell in 1975 documented high rates of stress-related disability among police officers in departments across the country and identified several contributing job stressors such as crisis situations, shift work, poor community perception, and work overload (Kroes & Hurrell, 1975).

As described in a review article by Abdollahi (2002), a complex array of factors have been shown to be associated with police stress, which is related in part to the various approaches taken by researchers to examine stress (Abdollahi, 2002). She proposes that it is helpful in our understanding of police stress research to group related stressors into the following categories:

intra-interpersonal, occupational, and organizational. Intra-interpersonal stressors include specific personality traits or interaction with others that can lead to stress; those who possess personality traits such as hardiness and self-confidence have been shown to experience less strain in a stressful event (Tang & Hammontree, 1992). Occupational stressors are those specific job tasks in law enforcement that are potentially life threatening and are frequently measured in this occupation as a source of stress. Examples of these stressors are death of a fellow officer, shooting related incidents, motor vehicle crashes, encountering victims of crime (especially children), unpredictable situations, public scrutiny, and dealing with the judicial system (Violanti & Aron, 1994).

While critical incidents constitute a small proportion of the total activity experienced by a responder, they represent a significant source of stress. Organizational stressors such as equipment not working, daily operational hassles, being unclear about work roles, stressful relationships with coworkers, inadequate department support, shift work, long working hours, or feelings of discrimination can add to the stress experienced on a routine basis (Maguen et al., 2009; Collins & Gibbs 2003; Carlier et al., 1997; Violanti & Aron, 1995). Organizational stressors have been found to be highly predictive of burnout, PTSD, depression, anxiety, and unhealthy coping behaviors in this profession. In addition, depressive, PTSD, and anxiety symptoms may increase the risk of suicidal ideation and eventual suicide among police officers, especially if other factors are present such as personal stressors, alcohol use, and lack of social support (McFarlane et al., 2009; Violanti, 2004; Robinson et al., 1997).

Stress and mental health consequences of injury

A study by Carty et al. (2005) demonstrated a large proportion of injury survivors from the general population in Australia admitted for hospitalization were diagnosed with delayed onset PTSD-12 months after event, where researchers suggest risk of psychological morbidity may be delayed due to ongoing physical disability and limited available resources following traumatic injury (Carty et al., 2006). In addition, research evidence suggests that those who have experienced an injury are more at risk for suicide than uninjured individuals in the general population, which demonstrates how mentally debilitating an injury can be for an individual (Ryb et al., 2006).

Experiencing an occupational injury is a likely source of stress for a first responder and this psychological distress may be a major indicator for risk of long-term mental health sequelae such as PTSD, depression, acute stress disorder, and anxiety (Mason et al., 2006). In a study of World Trade Center disaster rescue workers, experiencing an injury was a risk factor for PTSD (Perrin et al., 2007) and depressive symptoms in police after Hurricane Katrina (West et al., 2008). In addition, experiencing minor injury was reported as a duty-related incident stressor by urban firefighter/paramedics (Beaton et al., 1998). A recent study examining the impact of injuries in police officers in Finland found that police officers who had suffered frequent injuries reported a higher prevalence of adverse mental health outcomes than those who had not experienced an injury (Leino et al., 2012). Some research has looked at the effect of traumatic injury among combat veterans. Koren et al. (2005) found injured soldiers were 2-3 times more likely to report PTSD than those who were not injured during combat, although the context may differ in importance from experiencing an injury in civilian life (Koren et al., 2005).

Research examining the association of *extent and severity* of injury and PTSD symptoms has produced mixed findings. Typically injury severity is measured using the injury severity score (ISS), which is a summed score based on the severity and self-reported location of the injury on the body (Baker et al., 1974) and it has shown utility in determining extent of health care access (Gabert-Quillen et al., 2011). However, inconsistent findings have been produced when analyzing the relationship of the ISS with PTSD symptoms; with some studies finding a positive association between injury score and PTSD (Jeavons et al., 2000; Frommberger et al., 1998; Perry et al., 1992) and others finding no relationship between injury severity and PTSD symptoms (Zatzick et al., 2002b; Dougall et al., 2001). Conflicting findings could be due to how injury is assessed—either subjectively (self-report using ISS or other scales) or objectively measured (using metrics assessing actual injury). Previous research by Lazarus (1984) has highlighted the value of subjective appraisal in predicting distress, suggesting that an individual’s interpretation of a traumatic event should be more strongly related to psychosocial morbidity (Lazarus & Folkman, 1984). It has also been recommended that objective injury severity should be used in conjunction with measures of subjective responses in order to determine how related they are to one another, and how they may differentially predict PTSD (O'Donnell et al., 2003). A recent study looking at risk factors for posttraumatic symptoms found perceived injury severity to be a better predictor of symptoms than objective measures (Gabert-Quillen et al., 2011).

Some studies have examined individual predictors of adverse mental health outcomes after injury. A study of military personnel post-deployment found that irrespective of injury severity, pre-existing psychiatric disorders, use of psychotropic drugs, and presence of life

stressors were significantly related to post-deployment PTSD (Sandweiss et al., 2011). Other studies have identified the following predictors of poor mental health outcomes post injury: peritraumatic dissociation and emotion, chronic pain, female sex, perceived threat to life, limited social support and financial resources, family history of psychopathology, history of maladaptive coping responses, and prior trauma (O'Donnell et al., 2008; Ozer et al., 2003). It is thought that chronic pain after injury is associated with poor mental health outcomes such as depression, PTSD and ASD through its role as an inescapable stressor that activates the HPA axis, as demonstrated in animal models (Blackburn-Munro & Blackburn-Munro, 2001). Chronic pain and perceived stress have been found to affect sleep quality and have been correlated with psychological conditions such as depression (Cho et al., 2012; Kashani, 2012; Wilson et al., 2002). Other researchers are examining the role of sleep quality on psychological stress and health consequences in police officers with some finding that sleep quality mediates the relationship between health functioning and psychological morbidity (Vila, 2006; Neylan et al., 2002).

In 2013, female officers comprised 13.4 percent of the U.S. police force; in comparison, participation by women was 57.2 percent in the U.S. labor force overall (BLS, 2013). Aside from the typical stressors inherent in the profession, female officers may be susceptible to higher stress levels than their male counterparts due to discrimination in a largely male-dominated profession. Some have reported that they feel more socially isolated than their male counterparts as a result, which could lead to safety issues if, for example, female officers are not getting adequate backup in the field by male officers. In addition, female police officers have reported that experiencing sexual harassment, conflict with coworkers, and difficulty with work-family

conflict were significant stressors (Lilly et al., 2009; Somvadee & Morash, 2008; Morash et al., 2006; Liberman et al., 2002). Several studies have found women in the general population are more likely to report depression and anxiety disorders than men (Altemus, 2006; Breslau et al., 1997; Kessler et al., 1994). However, reports of gender differences in military and police occupations have been mixed, with some reporting less PTSD and depressive symptoms than women civilians (Fullerton et al. 2001). Lilly et al. (2009) found women police officers reported less PTSD symptoms, but used more alcohol and reported more somatization than women civilians (Lilly et al., 2009). They speculate that training women may help decrease vulnerability to PTSD in comparison to the general female population and may use more effective coping strategies to deal with stress than men. In addition, they suggest that women who are selected in policing and military occupations may suppress peri-traumatic emotion (a criterion for PTSD diagnosis), where there is a tendency not to express fear in the face of critical incidents in order to compete successfully in a male-dominated profession.

Injury on duty and healthy and unhealthy coping behaviors

Individual characteristics such as personality and coping style are important in predicting whether certain job conditions will result in stress (NIOSH, 1999). For police officers, effective coping and problem solving have been shown to be important buffers against stress and adverse mental health outcomes (Marmar et al., 2006). Researchers have recommended that future studies examine the role of potential modifiers, such as coping, when assessing psychological morbidity after injury (Gabert-Quillen et al., 2011). In general, police officers are thought to have a higher level of resiliency than other occupational populations because they undergo pre-employment and in some cases ongoing physical and psychological medical screening; however,

this level of resiliency may not be as potent a buffer after a traumatic injury and after repeated exposure to acute and chronic life stressors.

Social support has been shown to be a strong predictor of PTSD due to its protective role in the aftermath of a critical incident (Prati & Pietrantonio, 2010). For those with social support, available resources may be more plentiful, may influence the appraisal of the event, and promote adaptive coping mechanisms but the exact mechanism for this buffering effect is debated. Coworker support may be especially important for first responders after critical incidents; as reported by firefighters it is more helpful to get help and reassurance from coworkers that have experienced the same event (Fullerton et al., 1992). Support networks may not be as extensive in the law enforcement community as compared to other first responder populations because of the propensity in police culture to be suspicious of others, strongly self-reliant, and more socially isolated (Johnson et al., 2005; Miller, 2005; Lonsway, et al., 2002).

Research has shown that increased substance use, inactivity, poor sleeping habits, and overeating can result from injury (McCarthy et al., 2003; Williams et al., 2003). The stress of the injury may also cause individuals to engage in more substance use. Alcohol and other substance use may also coexist with depression, PTSD, and other anxiety symptoms, which may mask anxiety symptoms or make them worse (NIMH, 2009; NIMH, 2008; Bryant, 2006). Past studies have shown the tendency for police personnel to use alcohol as a social and psychological device for coping with stresses on the job (Violanti et al., 1983). Gershon et al. (2002) found that in police officers, high stress levels were associated with unhealthy risky behaviors such as problem drinking and aggressive behavior (Gershon et al., 2002). In another study on predictors of suicide in police, alcohol use modified the relationship between PTSD and suicidal ideation (Violanti, 2004).

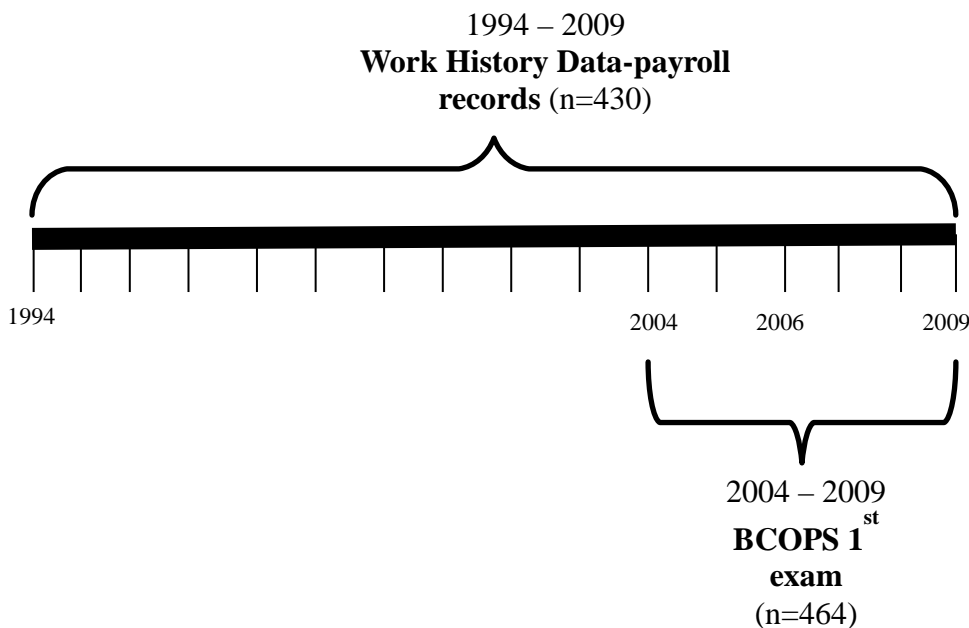
Research Methods

This dissertation utilized data from the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) Study, a cohort study of active duty police officers from the Buffalo (NY) police department, which is a mid-sized urban police department consisting of 810 police officers as of 2004. The BCOPS study includes payroll (work history) records and aims to elucidate the effects of policing and stress on adverse metabolic and early stage (subclinical) cardiovascular outcomes with the ultimate goal of preventing these and other stress-related disorders. The study employs use of physiologic and self-reported measures of stress, adverse metabolic outcomes, psychosocial outcomes, and subclinical cardiovascular outcomes. Data collection was performed at The Center for Preventive Medicine, State University of New York at Buffalo. This study was approved by the Internal Review Board of the State University of New York at Buffalo, and the Human Subjects Review Board of the National Institute for Occupational Safety and Health.

The payroll work history data were used to assess injury on duty occurrence (exposure) from 1994 to 2010 for each participating officer and the BCOPS study data was the source of outcome and other covariate data. All 810 police officers were invited to participate in examinations for the BCOPS study during the period of May 21, 2004 to October 2, 2009. As part of the exams, participants completed questionnaires and underwent additional objective testing. To be included in the BCOPS study a participant had to be an active sworn police officer, not on long-term leave, and not pregnant. One hundred officers who were on extended leave due to illness, disability or suspension and 2 pregnant officers were excluded; 110 officers did not participate due to retirement, leaving the force, or death; 134 chose not to participate. These exclusions yielded a cohort of 464 participants who completed examinations for the

BCOPS study (Violanti et al., 2006), with a participation rate of 57%. Payroll work history data were available for 430 of the 464 BCOPS study participants from 1994 to 2009, see Figure 1.1.2.

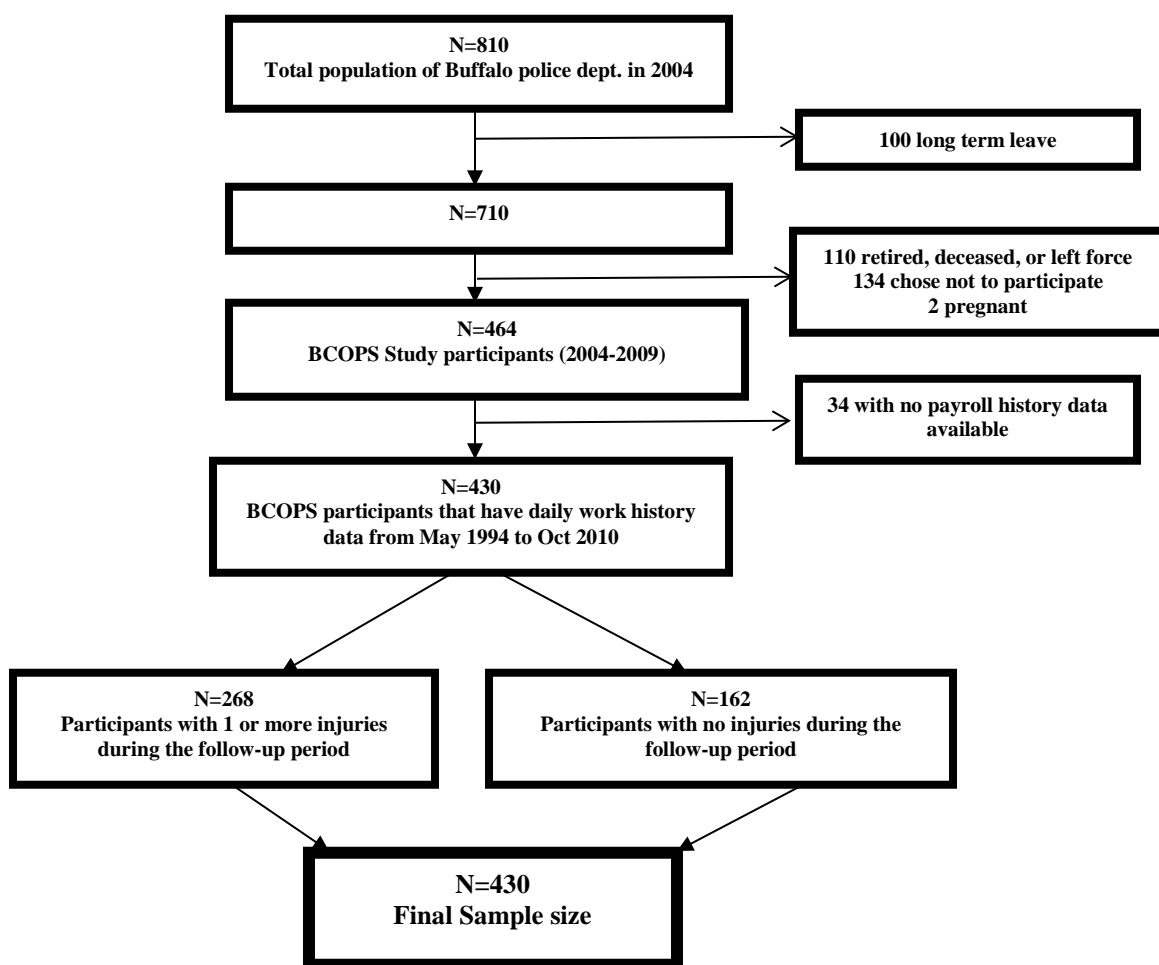
Figure 1.1.2.: Timeline of Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from work history records, 1994-2009; N=430



The payroll work history data contained a day-by-day account of activities for each officer including shifts, activity type (regular time work, court work or overtime work), leave, sickness and injury information, and the specific hours worked. The past payroll work history records were also used to ascertain new cases of injury, the date of first injury, and the shift during which the injury occurred. The work history data contained a daily indication of whether or not the officer was working. If the officer was not working, it indicates the reason (being on vacation, sick leave, leave due to on-duty injury, etc.). A new on-duty injury occurred when the payroll record indicated that an officer was paid for regular work but was on disability leave due to on-duty injury. Figure 1.1.3 provides a sampling frame for the study including a breakdown of

the study sample, reasons for exclusion of BCOPS participants, and distribution of injury status based on payroll records. Information was not available on type or nature of injury.

Figure 1.1.3: Sampling frame of Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from work history records, 1994-2009; N=430



Instruments and derived variables

Injury

Information on injury on duty (exposure) is derived from the payroll work history data. A definition of yes/no injury has been constructed for ever having been injured while on duty. An officer is at risk for developing a new injury following a full day of regular time work after a previous injury. Using this definition, the number of injuries for each participant was determined and counted. The duration of injury was determined by summing the number of days including weekends that a participant was on disability leave due to on-duty injury. Recency of injury was defined using time from injury leave to first exam date.

Stress

Perceived stress was assessed using the Perceived Stress Scale (PSS), an original 14-item self-reported questionnaire that asks about feelings and thoughts during the past month. Participants rated each item on a five-point scale based on the frequency with which a particular event was experienced: 0 (never), 1 (almost never), 2 (sometimes), 3 (fairly often), and 4 (often). The total PSS scores were obtained by summing across all 14 items; the scores ranged from 0 to 56, with higher scores indicating higher stress (Spacapan & Oskamp, 1988; Cohen et al., 1983).

Behavioral factors, coping, and sleep quality

Smoking status was defined using the smoking history questionnaire; categories of smoking included never, current, or former smoker. Never smokers were those who reported never smoking or who smoked fewer than 100 cigarettes, 20 times from a tobacco pipe, or 20 cigars in their lifetime. Current smokers were those who currently smoke cigarettes, tobacco pipe, or cigar. Those who reported they smoked at least 100 cigarettes, 20 times from a tobacco

pipe, or 20 cigars in their lifetime but currently do not smoke and quitting more than 1 month prior to questionnaire completion were defined as former smokers. The total number of cigarettes smoked per day reported for current smokers was also used. Alcohol use was determined by asking officers how often they consumed alcoholic beverages with one drink defined as a 12-oz. can or bottle of beer, one medium glass of wine, or one shot of liquor. For current and former (recent) alcohol drinkers, the total number of drinks consumed per week was used. The Alcohol Use Disorders Identification Test (AUDIT) was used as a screen for extent of problematic alcohol use. It contains 10 questions with responses ranging from 0 to 4, responses were summed and the total score was used in the analysis. A dichotomized variable was created, with 8 or more, considered an indicator of hazardous or harmful alcohol use, as well as possible alcohol dependence (Babor et al., 2001).

Sleep quality and duration was assessed using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. Sleep quality was obtained from 19 self-rated individual questions that assessed various sleep quality related factors over the previous one-month period. These 19 items were grouped into seven components that include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each component was scored by summing the scores of each item. Each item was weighted equally on a 0 – 3 scale. A global PSQI score was derived by summing up the seven component scores with a possible range of 0 – 21; a global score of >5 defines poor sleep quality (Buysse et al., 1989).

Hardiness/resilience was measured using the 15-item scale consisting of three dimensions including control, commitment, and challenge (Bartone 2007). For this instrument participants respond on a 4-point scale indicating level at which each of the 15 statements apply to them as

follows: 0 (not at all true); 1 (a little true); 2 (quite true); 3 (completely true). Scores were obtained by reverse coding and summing items for each dimension. The overall hardiness score is obtained by summing all 15 items. Coping was measured using the Brief COPE index, which has 14 sub-scales each with its own score (Carver, 1997). The three main indices are proactive cope, passive cope, and support cope and a global score was used in the analysis. Social support was assessed via self-report using the 24-item Social Provisions Scale designed to assess six relational provisions consisting of six subscales (each with four items). Items were rated on a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). A global score was used in the analysis.

PTSD, depression, and anxiety

Information on PTSD, anxiety, and depressive symptoms comes from self-reported questionnaire data. Depressive symptoms were measured using the Center for Epidemiologic Studies Depression (CES-D) scale which is a 20-item measure of symptoms of depressed mood. Respondents rated items on a 4-point scale based on the frequency of symptom occurrence in the previous seven days: 0 (rarely or none of the time, less than 1 day), 1 (some or little of the time, 1-2 days), 2 (occasionally or a moderate amount of time, 3-4 days), and 3 (most of the time, 5-7 days) with a total possible score of 60. A score of 16 or higher is generally considered indicative of depressed mood (McDowell & Newell 1996; Radloff, 1977). PTSD was measured using the 17-item PTSD Checklist-Civilian Version (PCL-C), which has been validated in adult populations (Sandweiss et al., 2011; Brewin, 2005; Blanchard et al., 1996). Participants were defined as having PTSD based on their report of the three criteria: intrusion—recurrent and intrusive recollections of the event, avoidance-detachment and efforts to avoid thoughts, feelings of event, and hyperarousal-difficulty sleeping and concentrating, hypervigilance. Anxiety was

measured using the Beck Anxiety Inventory (BAI), a scale designed to measure the severity of anxiety (Beck et al., 1988) from 21 common symptoms of anxiety in the past 2 weeks. The BAI is used to evaluate anxiety symptom severity with the cutoff indicating minimal (0-7), mild (8-15), moderate (16-25), and severe (26-63) symptom presentation.

Demographics, work characteristics, and health history

Officers were given self- and interviewer-administered questionnaires to provide information on demographic characteristics, lifestyle behaviors, and health history. Age, gender (male/female), race (white/black/Hispanic), and marital status (single/married/divorced) all were measured through self-report. For work characteristics, rank, working hours, and years of service were measured from self-administered questionnaire; shift work, number of hours worked, and overtime were derived from payroll/work history data. Rank was collapsed into three categories for the current analysis: patrol police, sergeant/ lieutenant, and captain/ detective/ executive/ others. Traumatic history was measured using a question that asked if participants had any previous traumatic experience prior to coming into police work.

Statistical Analysis

Analyses were performed using SAS 9.3. Descriptive analyses were conducted by examining distributions of each of the variables and quantitatively summarizing demographic and work characteristics, injury variables, perceived stress, unhealthy behaviors, depression, anxiety, and PTSD in the study population. Characteristics of participants with and without injury and characteristics of those with and without stress, health behaviors, PTSD, depression,

and anxiety were compared. Variance inflation factors from regression analysis of selected covariates were examined to assess multi-collinearity. Student t-tests and analysis of variance (ANOVA) were used to compare mean values of continuous covariates by category and Chi-square tests were used to examine the relationships between categorical covariates. For each of the aims, regression models were fit separately to include the continuous and categorical definitions of injuries, including the injury occurrence, number of injuries, duration of injury, and recency of injury. Specific analyses for each of the aims are included in subsequent chapters.

Using previous findings from the BCOPS study, the percentage of subjects with adverse psychological symptoms was approximately 40% and the percentage of subjects with an occupational injury was 62%. However the conditional values (percentage of those with and without psychological symptoms that have been injured) are unknown. Leino et al. (2012) examined the association between injury and adverse mental health in police officers, and reported the proportion of exposed controls (subjects without psychological distress who experienced an occupational injury) to be 0.610 (Leino et al., 2012). For an odds ratio of 2, power at 80%, two-sided test at 0.05 level, and a 10% increase for each additional covariate (6), yields a sample size of 233 for each group. Based on these parameters, the current study sample size of 430 represents an adequate number of subjects to detect differences in outcomes between exposed and unexposed groups.

The following three chapters address the research questions proposed by this dissertation. Chapters 2, 3 and 4 describe the prevalence, frequency, duration, and recency of injury leave in this population. Chapter 2 evaluates the association of the 4 selected injury definitions with perceived stress among U.S. police officers. Chapter 3 evaluates the association of the 4 selected injury definitions with increased smoking, alcohol dependence, and poor sleep quality among

police officers and the role of poor sleep quality as a mediator in the association of injury and psychological distress symptoms. Chapter 4 examines associations of the 4 selected injury definitions with depression, PTSD, and anxiety among police officers. Chapter 5 provides a discussion of the findings, policy implications, future research needs, and conclusion.

CHAPTER 2

On-duty non-fatal injury among police officers and level of perceived stress

Abstract:

Introduction: My aim was to examine the prevalence, frequency, duration, and recency of injury leave and the association of duty-related injury and perceived stress in U.S. police officers.

Methods: The population for this cross-sectional study was 430 active duty police officers (mean age=43, 74% males) from a mid-sized urban police department. Payroll work history data were obtained to assess occurrence of on-duty injury from 1994 to 2009 for each participating officer. Enrollment occurred between 2004 and 2009 when self-reported stress was measured. Linear regression analyses were conducted controlling for potential confounders, comparing perceived stress in those with and without injury.

Results: Most participants had experienced an injury (62%) and among those injured 67 percent experienced more than one duty-related injury. The average number of injuries per officer between 1994-2009 was 3 (range 1-12). The average number of days away from work due to the duty-related injury was 210 (range of 1-2250) and 49 percent had taken more than 90 days off work due to an injury. Most (72%) participants had an injury in the last 5 years. The average perceived stress score in this sample was 20.3 (SD=7.8). After controlling for age, rank, and sex, the estimated perceived stress score was higher in injured (20.6, SD=0.5) compared to not-injured (20.0, SD=0.6) participants, but this difference was not statistically significant. There was a significant linear trend in mean perceived stress across injury count even after adjusting

for age, rank, and sex ($p=0.025$). No significant association between mean perceived stress scores and duration of injury was found.

Conclusion: Findings suggest work-related injury is common and repeated work-related injuries are psychologically distressing in U.S. police officers. Targeted and timely clinical and workplace interventions to prevent serious psychological symptom development and to direct limited resources for resilience training and early intervention are needed.

Introduction:

Police work involves exposure to multiple critical incident stressors including the risk of being seriously injured or killed. The most common nonfatal injuries among law enforcement officers are attributable to assaults, transportation incidents, and training incidents that result in sprains, strains, contusions, and abrasions (Maloney, 2014; Reichard & Jackson, 2010; LaTourrette et al., 2008; Houser, 2004). Such incidents may occur more than once throughout an individual's work history. In 2011, as part of the Survey of Occupational Injuries and Illnesses (SOII), states reported total nonfatal injuries and illnesses for public sector employees. As reported from the SOII, police and sheriff's patrol officers had among the highest percentage of injuries requiring days away from work compared to other local and state government workers (Maloney, 2014; Brown, 2011).

In recent years, researchers have begun to demonstrate empirically the social and economic consequences of occupational injuries. Many physical, psychological, social, and behavioral changes occur in the aftermath of a moderate to severe occupational injury. These changes can occur with repeated injuries, even if they are less severe (Richmond & Kauder, 2000). An occupational injury can be thought of as a critical incident that can cause added pressure on career performance and tax an individual's emotional resources, resulting in a range of responses such as exhaustion and chronic mental health symptoms (Maguen et al., 2009; Kim 2008; O'Donnell et al., 2004). Long-term financial hardship, limited ability to perform activities of daily living, and shifts in family dynamics associated with loss of income and disability can add to the emotional and physical burdens that accompany injuries (Strunin & Boden, 2004; Dembe, 2001; Pransky et al., 2000). The occurrence of occupational injury may be especially distressing for law enforcement officers given that they must rely on a high level of physical

functioning to perform their jobs. In addition, although many first responders are able to obtain disability income, the absence of overtime pay due to disabling injury can place additional financial strain on a responder who regularly relies on overtime pay as part of their income (Senjo, 2011).

Stress in law enforcement has been extensively documented. Many potential sources of stress have been described, including exposure to traumatic or violent events, extended work hours, shift work, a negative public image, supervisor/coworker conflict, and equipment not working (Violanti & Aron, 1994). Racism and sexual harassment may be a source of additional stress for minority and female officers (Gershon et al., 2009). The accumulation of organizational, operational, and interpersonal pressures has been shown to lead to burnout, PTSD, depression, anxiety, and unhealthy coping behaviors in this profession (McFarlane et al., 2009; Violanti, 2004; Robinson et al., 1997). The psychosocial stress model describes how one's perceived capacity to handle situational demands can be overcome by the inability to cope with such demands (Lazarus, 1984). A person may appraise the condition (i.e. traumatic event) as stressful if they determine they do not have the available resources to deal with it.

This paper focuses on injury and perceived stress for law enforcement personnel with the expectation that findings can be generalized to other first responders to improve health and safety promotion efforts in these groups. An injury in the life of a police officer is likely perceived as stressful and represents an important stress antecedent that has not been previously examined in this population. My aim was to examine the prevalence, frequency, duration, and recency of injury leave and the association of duty-related injury and perceived stress in U.S. police officers. Identifying and defining risk factors for psychological distress resulting from traumatic

and non-traumatic injury will aid in development of prevention strategies in first-responder groups.

Methods

For this research, I utilized data from the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) Study, which is a cross-sectional study of active-duty police officers from the Buffalo (NY) Police Department, a mid-sized urban police department with 810 officers. The BCOPS study aims to elucidate the effects of policing and stress on adverse metabolic and early stage (subclinical) cardiovascular outcomes with the ultimate goal of preventing these and other stress-related disorders. The study obtained physiologic and self-reported measures of stress, adverse metabolic outcomes, psychosocial outcomes, and subclinical cardiovascular outcomes. All 810 officers were invited to participate in the BCOPS study during the period of May 21, 2004 to October 2, 2009. Participants completed questionnaires and were interviewed once between 2004-2009, providing information on perceived stress and demographic characteristics, lifestyle behaviors, and health history. Payroll work history data were obtained to assess occurrence of on-duty injury from 1994 to 2009 for each participating officer. Data collection was performed at The Center for Preventive Medicine, State University of New York at Buffalo. The BCOPS study was approved by the Internal Review Board of the State University of New York at Buffalo and the Human Subjects Review Board of the National Institute for Occupational Safety and Health. This study was approved by the Health Sciences and Behavioral Sciences Institutional Review Board at the University of Michigan.

To be included in the BCOPS study a participant had to be an active sworn police officer, not on long-term leave, and not pregnant. One hundred officers who were on extended leave due

to illness, disability or suspension and 2 pregnant officers were excluded. An additional 110 officers did not participate due to retirement, leaving the force, or death, and 134 chose not to participate. This yielded a sample of 464 participants for the BCOPS study (Violanti et al., 2006). Payroll work history data were available for 430 of the 464 BCOPS study participants. For each subject, injuries from the work history data that occurred after the date of questionnaire completion in the BCOPS study were excluded. This yielded a final sample size of 430 for the present study.

The payroll work history data contained a day-by-day account of activities for each officer including shifts, activity type (regular time work, court work or overtime work), leave, sickness and injury information, and the specific hours worked. On-duty injuries were determined when the payroll record indicated an officer was on leave due to an injury sustained during working hours. The continuous leave period due to on-duty injury was defined as one injury event. From this, a binary variable was constructed for ever having been injured (yes/no). An officer was at risk for developing a new injury following a full day of regular time at work after a previous injury. Using this definition, the number of injuries for each participant was calculated (injury count) and categorized as one injury and more than one injury. The total number of days including weekends that a participant was on leave due to on-duty injury was calculated for each injury and was summed across injuries to get the total duration of injury leave for each subject. We used the injury with the longest continuous duration of days on disability leave to define duration of injury leave used in these analyses, which we categorized based on set administrative cut points. At 30 days leave officers typically qualify for short-term disability and at 90 days for long-term disability. We also defined a variable, recency of injury, based on the time interval from last injury to date of questionnaire completion.

Perceived stress was assessed using the Perceived Stress Scale (PSS), a 14-item self-reported questionnaire that asks about feelings and thoughts during the past month (Cohen et al., 1983). Questions focus on how unpredictable, uncontrollable, and overloaded respondents perceive their lives to have been over the past month. It is considered a valid predictor of stress-induced consequences, including burnout, physical symptoms, and job dissatisfaction and has shown good internal consistency in other studies (Cronbach's $\alpha=0.93$) (Figley, 2007; Kocalevent et al., 2007). Internal consistency for the total scale reached $\alpha=0.87$ for this study. Participants rated each item on a five-point scale based on the frequency with which a particular event was experienced: 0 (never), 1 (almost never), 2 (sometimes), 3 (fairly often), and 4 (often). The total PSS scores were obtained by reverse coding the 7 positively stated items and then summing across all 14 items; the scores ranged from 0 to 56, with higher scores indicating higher stress (Cohen et al., 1983).

Age, sex, race/ethnicity, marital status, and work characteristics were measured through interviews and self-administered questionnaires. Work characteristics, including rank, workload (light, moderate, or heavy), working hours, and years of service, were assessed by a questionnaire. Rank was collapsed into three categories for the current analysis: patrol police, sergeant/ lieutenant, and captain/detective/executive/others.

Statistical Analysis

I calculated prevalence, frequency, duration, and recency of injury leave. In addition, I examined distributions of variables and compared demographic and work characteristics of participants with and without injury and by mean values of perceived stress. Associations of potential confounders with injury and stress were examined. Student t-tests and analysis of variance (ANOVA) were used to compare mean values of continuous variables by category of injury. Chi-square tests were used to examine the relationships between categorical covariates. Multivariable linear regression models were constructed to examine the association of injury with perceived stress adjusted for possible confounders. Four types of injury were examined: injury status (any injury vs. no injury); count of injury (0 to 8 or more); duration of injury leave (0, <30, 30-89, \geq 90 days), and recency of injury (less than 1 year, 1-2 years, 2-3 years, 3-5 years, and 5 or more years). I also assessed potential interactions between the injury variables and age, sex and rank interaction terms in multivariable linear regression models. Inclusion of select covariates in multivariable regression models was based on results of initial bivariate analyses, previously published literature, and observed appreciable change in the parameter coefficient of the main exposure as each potential confounder was introduced into the regression model. I used a sequential modeling approach where models were 1) unadjusted and 2) adjusted for age, sex, and rank. Statistical significance was assessed for all tests at the 5% level. All analyses were performed using SAS 9.3 (SAS Institute, Cary, NC, USA).

Results

Sixty-two percent of the participants had experienced an injury and of those who were injured, 67 percent experienced more than one duty-related injury. The average number of injuries per officer between 1994-2009 was 3 (range 1-12). The average number of days away due to a duty-related injury was 210 (range of 1-2250). Duration of injury leave varied, but 49% of participants had more than 90 days away from work due to duty-related injury. Of the duty-related injuries experienced by participants, 18% had the last injury one year prior and 72% had the last injury in the 5 years prior to the time of questionnaire completion. Demographic and lifestyle characteristics of study participants by injury status and mean perceived stress score are shown in Table 1.1. Overall, most of the participants were male (74%) with an average age of 43 years (range 27-70). Those who had experienced a duty-related injury were more likely to be younger, never smoked, have fewer years of service, and be a patrol officer. The average perceived stress score in this sample was 20.3 (SD=7.8). Women had a higher mean perceived stress score (22.5 ± 9.2) than men (19.6 ± 7.1).

Table 1.2 presents the association between perceived stress and injury status. Although mean perceived stress score was higher in those injured than not injured, the unadjusted and adjusted mean differences were not statistically significant, controlling for age, rank, and sex. There was a significant linear trend in mean perceived stress across injury count even after adjusting for age, sex, and rank ($p=0.025$) (Table 1.3). Perceived stress scores did not differ by duration of injury leave (Table 1.4). Lower stress levels were reported in participants with 500 or more days of leave ($n=10$) which could represent a special circumstance in the officer's career where the injury would not be considered as psychologically distressing. In my analyses I found these points exerted some leverage so I examined the association when those with 500 or more

days of leave were excluded. The association approached statistical significance after controlling for age, rank, and sex ($p=0.06$). Lastly I compared perceived stress scores by how recent the last injury was in relation to when perceived stress was measured. Although no statistically significant linear trend was found between mean perceived stress scores and recency of injury, a statistically significantly higher mean perceived stress was found for those with injury leave within 1 to 2 years of completing the baseline questionnaire compared to those with no injury ($p=0.0468$) after adjustment (Table 1.5). No significant effect modification was observed in the associations of injury and perceived stress score by age, sex, and rank (data not shown).

Table 2.1. Associations of demographic, lifestyle, and work history characteristics of study participants with injury status and perceived stress. Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from payroll records, 1994-2009; N=422

Characteristics	No injury n=162		Any injury n=268		p-value ¹	Perceived Stress Score n=422		
	n	%	n	%		n	Mean ± SE	p-value ²
Age								
<40 years	45	27.8	117	43.7	<0.0001	160	21.1 ± 7.9	0.2664
40-49 years	68	42.0	118	44.0		183	20.1 ± 8.1	
>50 years	49	30.2	33	12.3		79	19.4 ± 6.6	
Sex								
Women	40	24.7	70	26.1	0.7423	108	22.5 ± 9.2	0.0008
Men	122	75.3	198	73.9		314	19.6 ± 7.1	
Race								
White	129	81.7	202	75.9	0.2871	326	20.5 ± 8.0	0.3332
Black	26	16.5	60	22.6		84	19.2 ± 7.2	
Hispanic	3	1.9	4	1.5		7	21.6 ± 5.9	
Education								
≤High School/GED	20	12.4	30	11.2	0.3474	47	20.2 ± 8.2	0.8581
College <4 years	82	50.9	155	58.1		234	20.5 ± 8.0	
College ≥4 years	59	36.7	82	30.7		140	20.1 ± 7.2	
Marital Status								
Single	23	14.3	28	10.5	0.1528	51	21.3 ± 8.2	0.5600
Married	122	75.8	197	73.8		313	20.1 ± 7.5	
Divorced	16	9.9	42	15.7		57	20.6 ± 8.9	
Rank								
Patrol officer	83	52.2	209	78.6	<0.0001	287	20.3 ± 7.9	0.8086
Sergeant/Lieut/Capt	34	21.4	36	13.5		69	20.9 ± 8.8	
Detective/Exec/Others	42	26.4	21	7.9		62	20.2 ± 6.3	
Workload								
Low	9	5.8	10	3.8	0.6500	19	18.9 ± 7.7	0.4379
Moderate	49	31.4	82	31.4		128	20.9 ± 7.7	
High	98	62.8	169	64.8		265	20.0 ± 7.7	
Years of service								
0-9 years	39	24.1	66	24.7	<0.0001	104	20.4 ± 7.3	0.1731
10-14 years	13	8.0	76	28.5		89	21.3 ± 8.2	
15-19 years	36	22.2	59	22.1		93	21.0 ± 8.4	
>20 years	74	45.7	66	24.7		136	19.1 ± 7.2	

¹p-value: Compares covariates in those with and without injury

²p-value: Compares mean values of perceived stress by levels of covariates

Table 2.2. Unadjusted and adjusted mean perceived stress scores by injury status. BCOPS Study, 2004-2009, Injury data from payroll records, 1994-2010; N=422

Injury status	N	Model 1: Unadjusted	Model 2: Adjusted for age, sex and rank
Not injured	161	19.9 \pm 0.6	20.0 \pm 0.6
Injured	261	20.6 \pm 0.5	20.6 \pm 0.5
P-value ¹		0.3843	0.4183

¹p-value: T-test and ANOVA

Table 2.3. Unadjusted and adjusted mean perceived stress scores by count of injuries. BCOPS Study, 2004-2009, Injury data from payroll records, 1994-2009; N=422

Count of injuries	N	Model 1: Unadjusted	Model 2: Adjusted for age, sex and rank
0	161	19.9 \pm 0.6	20.0 \pm 0.6
1	87	19.6 \pm 0.8	19.6 \pm 0.8
2	61	21.5 \pm 1.0	21.2 \pm 1.0
3	44	21.1 \pm 1.2	20.9 \pm 1.2
4	25	19.7 \pm 1.5	19.8 \pm 1.5
5	18	17.7 \pm 1.8	18.0 \pm 1.8
6	8	19.5 \pm 2.7	19.6 \pm 2.7
7	6	22.2 \pm 3.1	22.8 \pm 3.1
8 or more	12	28.0 \pm 2.2	28.5 \pm 2.2
P-value ¹		0.0462	0.0254

¹p-value: Linear regression-Trend test

Table 2.4. Unadjusted and adjusted mean perceived stress scores by duration of injury leave. BCOPS Study, 2004-2009, Injury data from payroll records, 1994-2009; N=422

Duration of injury leave (days)¹	N	Model 1: Unadjusted	Model 2: Adjusted for age, sex and rank
0	161	19.9 \pm 0.6	19.9 \pm 0.6
1-30	84	20.5 \pm 0.8	20.6 \pm 0.9
30-89	71	19.8 \pm 0.9	19.6 \pm 0.9
\geq 90	106	21.2 \pm 0.8	21.4 \pm 0.8
P-value ²		0.9122	0.9085

¹Duration of injury leave that lasted longest

²p-value: Linear regression-Trend test

Table 2.5. Unadjusted and adjusted mean perceived stress scores by recency of injury leave. BCOPS Study, 2004-2009, Injury data from payroll records, 1994-2009; N=422

Recency of injury leave (years)¹	N	Model 1: Unadjusted	Model 2: Adjusted for age, sex and rank
No injury	161	19.9 ± 0.6	19.9 ± 0.6
<1	47	20.3 ± 1.1	20.5 ± 1.1
1-2	55	23.0 ± 1.0	22.8 ± 1.1
2-3	36	19.5 ± 1.3	19.7 ± 1.3
3-5	49	19.9 ± 1.1	20.0 ± 1.1
≥5 years	74	20.0 ± 0.9	20.0 ± 0.9
P-value ²		0.2670	0.3725

¹Recency of last injury to measurement of perceived stress

²p-value: Linear regression-Trend test

Discussion

This study examined whether the occurrence, frequency, duration, or recency of injury leave of duty-related injury was associated with levels of perceived stress in U.S. police officers. Most participants had experienced more than one duty-related injury and of those who were injured, half had taken extended time off of work due to the injury. Although the mean perceived stress score was a half point higher in injured compared to not-injured participant, this difference was not statistically significant. However, mean perceived stress scores did increase with number of injuries. These findings have shed light on the work-related injury experience and how it can lead to stress in U.S. public safety workers. It is worth noting that most of the officers in this study had been injured, most repeatedly, and much of the resulting leave was taken on a long-term basis. The prevalence of injuries was higher than that reported in other studies of police officers and first responders (Leino et al., 2012; Reichard & Jackson, 2010).

Repeated injury was the only injury measure that was found to be significantly associated with perceived stress after controlling for age, rank, and sex. One study examining sick or injury absence and work stress in police officers found a linear association between frequency of work-

related absences and stress, but did not find an association with number of days lost (Magnavita & Garbarino, 2013). A study of Finnish police officers examining psychological distress, using the 12-item version of the General Health Questionnaire, after experiencing a work-related injury found officers with two or more injuries had a higher risk of experiencing psychological distress symptoms compared to non-injured officers (Leino et al., 2012). Similar findings were reported in a study comparing symptoms of psychological distress between injured and uninjured workers. The author found greater emotional instability, depressive and anxiety symptoms in injured compared to uninjured workers and concluded the psychological consequences for workers who return to, or remain at work following injury may reduce adaptation and increase vulnerability to secondary work disability (Wall, 2008). These studies also suggest a dose-response effect of work injuries or sickness absence and level of psychological distress.

The lack of association found with duration of leave and perceived stress was surprising. However, my results suggest that duration of injury leave may be related to perceived stress if very long term leave (>500 days) was excluded. Duration of injury was used as an indicator of severity. The length of recovery time needed after injury has been used as a surrogate of injury severity in other studies (Irwin et al., 2014). Typically injury severity is measured using the injury severity score (ISS), which is based on a summed score of the severity and self-reported location of the injury on the body (Baker et al., 1974) and has shown utility in determining extent of health care access (Gabert-Quillen et al., 2011); but, the ISS was not used for this study.

The stress measure used in this study was one of many types of measures that could have been used. The PSS is a good instrument for measuring appraised stress; the questions are of general nature and are not specific to particular situations or populations. Stress is a complex phenomenon, influenced by a wide variety of factors, and the definition used in this study may

not capture the whole picture of police officers' stress experience and due to its general nature, the measure may not have focused narrowly enough on aspects of stress that are salient to this population. As a group, police officers are known to be reluctant to report symptoms of stress and alternative measures deserve further study. Inclusion of additional self-reported and physiologic measures of stress may broaden our understanding of the biology of stress response syndromes and physical disability. In addition, perceived stress levels were affected by time since participant's last injury leave. This analysis suggests that someone is likely to perceive his or her lives to be more stressful if the injury event occurred within 1-2 years. Collectively, these factors may have led to underestimated levels of perceived stress reported in this study.

Researchers have recommended that future studies examine the role of potential modifiers, such as coping, when assessing psychological morbidity after injury (Gabert-Quillen et al., 2011). In general, police officers are thought to have a higher level of resiliency than other occupational populations because they undergo pre-employment and in some cases ongoing physical and psychological medical screening; however, whether this level of resiliency remains as potent a buffer after a traumatic injury or after repeated exposure to acute and chronic life stressors requires future research.

An important limitation of the study is the absence of type, nature, or cause of injury from the payroll work history data. Psychological distress effects likely differ with type and nature of injury. The potential for loss of those who left the force prior to completing the BCOPS study surveys and interviews, and exclusion of those on long-term sick leave could have resulted in selection bias. An earlier comparison of demographic characteristics between participants and non-participants in the BCOPS study from the work history data found similar frequency distributions for sex, age, rank, and year of hire. This comparison included 95% of the officers

included in this analysis (Hartley et al. 2011). The extent that these findings are generalizable to other law enforcement and first responder populations may be limited as the study includes participants from one city police department. Additional studies in police and first responder populations in other areas of the U.S. are needed. Finally, there is some potential for reverse causation given the absence of concurrent health and injury information and the potential of stress leading to increased risk of occupational injury.

Conclusion

Findings of this study suggest that injury is common among police officers and repeated injury is associated with higher perceived stress. Findings from this research improve our understanding of the impact of injury in the line of duty for police. These findings have shed light on the work-related injury experience and how it can lead to stress in U.S. public safety workers. Results can be used to inform the future development of targeted and timely clinical and workplace interventions to prevent serious psychological symptom development and to direct limited resources for safety training and early intervention. These interventions may need to occur for an extended period of time, up to 1-2 years as my research suggests that the injury event may be still considered stressful.

CHAPTER 3

Behavioral and lifestyle factors and non-fatal injuries among police

Abstract:

Introduction: Consequences of being injured on the job have not been well examined in first responders. This paper examines the prevalence, frequency, and duration of injury in association with increased smoking, alcohol dependence, and poor sleep quality in police officers, and the role of poor sleep quality as a mediator in the association between injury and psychological distress symptoms.

Methods: This cross-sectional study evaluates 430 active duty police officers from a mid-sized urban police department as part of an ongoing cohort study of police officers. On-duty injury data were obtained from work histories covering the period 1994 to 2009 and all 430 police officers were invited to participate in the cohort study with enrollment occurring between 2004 and 2009. Surveys collected self-reported measures of mental health and behavioral factors. Bivariate and multivariate regression analyses were conducted controlling for potential confounders, comparing behavioral outcomes in those with and without injury. A mediation analysis was conducted to examine if sleep quality plays an important role as a mediator in the relationship between injury and psychological symptoms.

Results: Sixty-two percent of participants had experienced an injury; of those injured, 67% experienced more than one injury. The median number of days away from work due to duty-related injury was 86 (range of 1-2250) and 41% of injured officers had taken more than 90 days

off work. Of the study participants, 16% reported they were current smokers; approximately $\frac{3}{4}$ of the population reported current alcohol use and $\frac{1}{4}$ met the screening criteria for alcohol dependence. Over half reported consistently getting less than 7 hours of sleep during a 24 hour period and met the screening criteria for poor sleep quality. Smoking and alcohol dependence were not associated with injury occurrence or length of injury. A statistically significant positive trend was found between number of injuries and mean number of cigarettes smoked after adjustment for age, sex, and rank. Poor sleep quality was significantly associated with injury occurrence, number of injuries, and length of injury after adjustment for age, sex, and rank. I found that poor sleep quality mediated the effect of injury on adverse psychological outcomes (stress, PTSD, and anxiety) after controlling for age, sex, and rank.

Conclusion: Results suggest that smoking and poor sleep quality may be associated with work-related injuries and poor sleep quality may account for some of the association between injury and psychological distress effects for U.S. police officers. These findings improve our understanding of the impact of work-related injury among police.

Introduction:

Police work involves exposure to multiple critical incidents that can result in being seriously injured or killed. The most common nonfatal injuries among law enforcement are attributable to assaults, transportation incidents, and training incidents that result in sprains, strains, contusions, and abrasions/lacerations (IACP, 2012; Reichard & Jackson, 2010; LaTourrette et al., 2008; Houser, 2004). Such incidents may occur more than once throughout an individual's work life. According to U.S. Bureau of Statistics (2011), protective services occupations (including police officers, correctional officers, and similar groups) had a median number of 12 days off compared to seven days off in private industry in 2011 (BLS, 2011). On average, nearly 90% of line-of-duty police fatalities, and 50% of lost-time injuries were assault or vehicle related (Houser, 2004). As reported in the SOII in 2008 and 2011, police and sheriff's patrol officers had among the highest percentage of injuries that required days away from work compared to other first responders (Maloney, 2014; Brown, 2011).

In recent years, researchers have begun to demonstrate empirically the social and economic consequences of occupational injuries. Physical, psychological, social, and behavioral changes have been documented to occur in the aftermath of a moderate to severe occupational injury. Such changes also occur with repeated injuries even when they are less severe (Richmond & Kauder, 2000). An occupational injury can be thought of as a critical incident or traumatic event that can cause added pressure on career performance and tax an individual's emotional resources, resulting in a range of responses such as exhaustion, chronic mental health symptomology such as posttraumatic stress disorder (PTSD), depression, acute stress disorder, and anxiety (Maguen et al., 2009; Kim, 2008; O'Donnell et al., 2004; Mock et al., 2000). Overall, recovery and later disability have been linked to level of psychological distress post

injury (Richmond et al., 2003; Zatzick et al., 2002a). Long-term financial hardship, limited ability to perform activities of daily living, and shifts in family dynamics associated with loss of income and disability can add to the emotional and physical burdens that accompany injuries (Strunin & Boden, 2004; Dembe, 2001; Pransky et al., 2000).

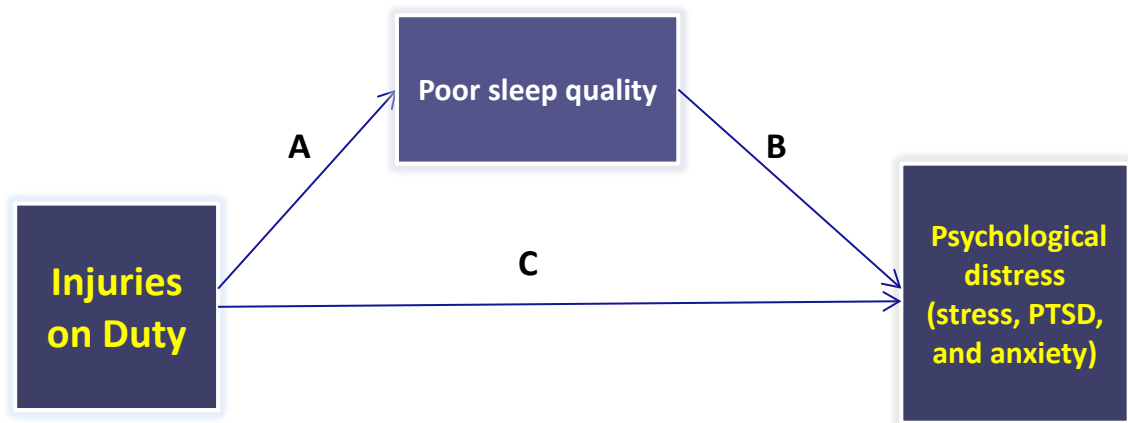
In addition to stress and adverse mental health symptoms, an increase in maladaptive coping behaviors may result following an injury event. Research has shown that increased substance use, inactivity, poor sleeping habits, and overeating can result from injury (McCarthy et al., 2003; Williams et al., 2003). The stress of the injury may also cause individuals to engage in more substance use. Substance use disorders have been shown to occur more frequently among patients who have been hospitalized for trauma surgery (Mock et al., 2000). Alcohol and other substance use may also coexist with depression, PTSD, and other anxiety symptoms, which may mask anxiety symptoms or make them worse (NIMH, 2009; NIMH, 2008; Bryant, 2006). Past studies have shown the tendency for police personnel to use alcohol as a social and psychological device for coping with stresses on the job (Violanti et al., 1983). This is supported by Gershon et al. (2002) who found that high stress levels in police officers were associated with unhealthy risky behaviors such as problem drinking and aggressive behavior (Gershon et al., 2002). In another study on predictors of suicide in police, alcohol use modified the relationship between PTSD and suicidal ideation (Violanti, 2004).

Chronic pain after injury has been shown to be associated with poor mental health outcomes such as depression, PTSD and ASD through its role as an inescapable stressor that activates the HPA axis as demonstrated in animal models (Blackburn-Munro & Blackburn-Munro, 2001). Chronic pain can affect sleep quality and these factors have been correlated with psychological distress and lead to conditions such as depression (Cho et al., 2012; Kashani,

2012; Wilson et al., 2002). Other researchers are examining the role of sleep quality on psychological stress and other health consequences in police officers with some finding that sleep quality mediates the relationship between health functioning and psychological morbidity (Vila, 2006; Neylan et al., 2002).

This paper examines the association of duty-related injury (frequency, duration, and recency of injury leave) and unhealthy coping behaviors (smoking, excess drinking), and poor sleep quality. I hypothesized an indirect effect of injury and PTSD, depression, and anxiety that is characterized by the pathway that goes through the measured intermediate variables: perceived stress and poor sleep quality as depicted in the model shown in Figure 1.1.4. In the model, the indirect effect is a product of the path coefficients “A” and “B” and it is a measure of the extent to which psychological distress symptoms changes when injuries are held fixed and sleep quality changes to the level it would have attained if injuries increased by 1. The direct effect is coefficient “C” in the model. The total effect is equal to the sum of the direct and indirect effects (“C + AB”) in the model and it is a measure to which extent psychological distress changes when the injuries increase by one (Hayes, 2013). Identifying these factors will elucidate the pathways resulting from traumatic and non-traumatic injury and will aid in development of primary and secondary prevention strategies in first-responder groups.

Figure 1.1.4 Conceptual and statistical model of direct and indirect effect of sleep quality on injuries and mental health outcomes



Methods

This cross-sectional study of active duty police officers from a mid-sized urban police department is part of an ongoing larger cohort study, the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study designed to examine the effects of stress and policing on mental and physical health. All 810 officers working as of 2004 in the department were invited to participate in the BCOPS study during the period of May 21, 2004 to October 2, 2009. To be included in the BCOPS study a participant had to be an active sworn police officer, not on long-term leave, and not pregnant. One hundred officers who were on extended leave due to illness, disability or suspension and 2 pregnant officers were excluded. An additional 110 officers did not participate due to retirement, leaving the police force, or death while 134 chose not to participate. This yielded a sample of 464 officers who participated in the BCOPS study (Violanti et al., 2006). Participants completed questionnaires and were interviewed once between 2004-

2009 providing information on psychological outcomes as well as on demographic characteristics, lifestyle behaviors, and health history.

Payroll work history data were obtained to assess occurrence of on-duty injury from 1994 to 2009 for each participating officer (injured and uninjured). The work history data contained a day-by-day account of activities for each officer including shifts, activity type (regular time work, court work or overtime work), leave, sickness and injury information, and the specific hours worked. An on-duty injury occurred when the payroll record indicated that an officer was paid for regular work but was on disability leave due to on-duty injury. Payroll work history data were available for 430 of the 464 BCOPS study participants and thus eligible for this analysis.

For each subject, injuries from the work history data that occurred prior to the date of questionnaire completion in the BCOPS study were included. Each continuous leave period due to on-duty injury was defined as one injury event. From this, a binary variable was constructed for ever having been injured (yes/no). An officer was at risk for developing a new injury following a full day of regular time at work after a previous injury. Using this definition, the number of injuries for each participant from 1994-2009 was calculated and categorized as one injury, two to three injuries, or three or more injuries. The total number of days, including weekends that a participant was on leave due to on-duty injury was summed to obtain the total length of injury leave period for each participant. Of these injury leave periods, I categorized duration of injury by quartiles as less than 17 days, 18 to 61 days, 62 to 159 days, and 160 or more days. The variable, recency of injury, was based on the time interval from most recent injury to date of questionnaire completion. The continuous and categorized version of this variable was used with the categories defined as less than one year, one to two years, two to three

years, three to five years, and five or more years. Thus, the four injury variables assessed here include: injury occurrence, number of injuries; duration of injury, and recency of injury.

Variables that describe smoking status were defined using the smoking history questionnaire; categories of smokers included never, current, or former. Never smokers were those who reported never smoking or who smoked fewer than 100 cigarettes, 20 times from a tobacco pipe, or 20 cigars in their lifetime, Current smokers were those who reported they currently smoke cigarettes, tobacco pipe, or cigar. Those who reported they smoked at least 100 cigarettes, 20 times from a tobacco pipe, or 20 cigars in their lifetime but currently do not smoke were further defined as former smokers. The total number of cigarettes smoked per day reported for current smokers was also used. Current alcohol use was determined by asking participants if they've had at least 12 drinks of any kind of alcoholic beverage and if they drink now. They were also asked how often they consumed alcoholic beverages with one drink defined as a 12 ounce can or bottle of beer, 6 ounces glass of wine, or 1.5 oz. shot of liquor. For current alcohol drinkers, the total number of drinks consumed per week was used. The Alcohol Use Disorders Identification Test (AUDIT) was used as a screen for extent of problematic alcohol use. It contains 10 questions with responses ranging from 0 to 4, responses were summed and the total score was used in the analysis. A dichotomized variable was created of 7 or fewer and 8 or more, the latter considered an indicator of hazardous and harmful alcohol use, as well as possible alcohol dependence. This scale has demonstrated good reliability and validity, and has been tested in various cultures and settings. It has been found to correlate well with measures of drinking consequences, attitudes toward drinking, vulnerability to alcohol dependence, negative mood states after drinking, and reasons for drinking (Babor et al., 2001).

Sleep quality and duration was assessed using the Pittsburgh Sleep Quality Index (PSQI). Sleep quality was obtained from 19 self-rated individual questions that assessed various sleep quality related factors over the previous one-month period. These 19 items were grouped into seven components that include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each component was scored by summing the scores of each item. Each item was weighted equally on a 0 – 3 scale. A global PSQI score was derived by summing up the seven component scores with a possible range of 0 – 21. A global score of 5 or more was used to define poor sleep quality and used as dichotomized variable in the analysis (Buysse et al., 1989).

The mental health variables measured were perceived stress, depression, PTSD, and anxiety. Perceived stress was assessed using the Perceived Stress Scale (PSS), a 14-item self-reported questionnaire that asks about feelings and thoughts during the past month (Spacapan & Oskamp, 1988). Depressed mood was measured using the 20-item Center for Epidemiologic Studies Depression (CES-D) scale (McDowell & Newell, 1996; Radloff, 1977). PTSD was measured using the 17-item PTSD Checklist-Civilian Version (PCL-C) (APA, 2000). The Beck Anxiety Inventory (BAI) was used to measure anxiety (Beck et al., 1988). The respondent was asked to score 21 common symptoms of anxiety in the past 2 weeks.

Age, sex, race/ethnicity, marital status, and work characteristics were measured through interviews and self-administered questionnaires. Work characteristics included rank, working hours, and years of service. Rank was collapsed into three categories: patrol police, sergeant/lieutenant, and captain/detective/executive/others.

Data collection was performed at The Center for Health Research, State University of New York at Buffalo. The BCOPS study was approved by the Internal Review Board of the

State University of New York at Buffalo and the Human Subjects Review Board of the National Institute for Occupational Safety and Health. Analyses for this paper were approved by the Health Sciences and Behavioral Sciences Institutional Review Board at the University of Michigan.

Statistical Analysis

I examined distributions of each variable and compared demographic and work characteristics of participants with and without injury. For descriptive purposes, frequency and percentage of behavioral characteristics by age, gender and rank were also computed. Student *t*-tests and analysis of variance (ANOVA) were used to compare mean values of continuous variables by category of injury and chi-square tests were used to examine the relationships between categorical covariates. We used multivariable linear regression to examine the association of injury with mean number of cigarettes smoked per day for current smokers, AUDIT score, and sleep quality score adjusted for possible confounders. For linear regression models, continuous and categorical versions of the injury variables were used. Log-binomial models were fitted to determine associations between injury and dichotomous forms of current smoking, alcohol dependence, and poor sleep quality. Adjusted prevalence ratios were generated using SAS Genmod procedure and COPY method for common outcomes (Deddens & Petersen, 2008). Unadjusted and adjusted means and prevalence ratios were calculated. Inclusion of select covariates in multivariate regression models was based on results of initial bivariate analyses and previously published literature. Separate models were tested for each of the four injury variables with each of the three psychological outcomes. We used a sequential modeling approach where models are 1) unadjusted and 2) adjusted for age, sex, and rank, and 3) adjusted for age, sex,

rank, and traumatic experience before police work. Twelve models were tested but only unadjusted and fully adjusted models are presented for this paper.

I also conducted a mediation analysis to examine whether sleep quality plays an important role as a mediator in the relationship between injuries and psychological symptoms using Hayes bootstrapping method which employs a statistical mediation macro (Hayes, 2013). The method is a non-parametric test that estimates the sampling distribution by repeatedly resampling the original data. In the current analysis, the bootstrapped mediation was done with 10,000 resamples. For each random sample, the mediated effects were computed. The method provides point estimates and 95% confidence intervals (CI) by which one can assess the significance or non-significance of a mediation effect of sleep quality and the mental health variables. The method does not rely on assumptions of normality, is recommended for small sample sizes, and considered to be more appropriate than traditional mediation approaches (Hayes, 2013, Baron & Kenny, 1986). I used age, rank and sex as covariates. The analysis was conducted separately for each of the mental health outcomes. The indirect effect for sleep quality as a mediator was statistically significant if the resulting confidence intervals didn't contain 0. All other statistical significance was assessed for all tests at the 5% level. All analyses were performed using SAS 9.3 (SAS Institute, Cary, NC, USA).

Results

Demographic and lifestyle characteristics of study participants by injury status are shown in Table 3.1. Overall, most of the participants were male (74%) with an average age of 43 years (range 27-70). A larger proportion of those who had experienced a duty-related injury were younger, had fewer years of service, and were a patrol officer.

Nearly two-thirds (62%) of the participants had experienced an injury. Of those who were injured, 67 % experienced more than one duty-related injury with the average number of 3 injuries (range 1-12). The median number of days on leave due to a duty-related injury was 86 (range of 1-2250). Duration of injury leave varied, but 41% of participants had more than 90 days away from work due to duty-related injury. When I examined recency of injury, 29% had their most recent injury within one year, and 24% in the 5 or more years prior to the time of questionnaire completion.

Table 3.2 presents the frequency of current smoking, alcohol use greater than 7 drinks, alcohol dependence, inadequate sleep, and poor sleep quality by select demographic characteristics. Overall, 16% of the study population reported they were current smokers, 85% reported current alcohol use, 27% met the screening criteria for alcohol dependence, 64% reported having less than 7 hours of sleep, and 54% met the screening criteria for poor sleep. A higher percentage of younger participants reported smoking (20 vs. 14%), alcohol use (24 vs. 22%), and alcohol dependence (32 vs. 22%) than older participants. More female than male participants reported smoking (26 vs. 13%) and drinking (86 vs. 84%). However, more male than female participants reported alcohol dependence (17 vs. 29%). A higher percentage of participants with the rank of patrol officer reported smoking (18 vs. 12%) and drinking (87 vs. 84%) than all other ranks. The overall mean/median scores of the psychological outcomes in this

sample were 7.8 (SD=6.9)/6.0 (IQR=7.5) for depressive symptoms, 26.3 (SD=8.9)/24.0(IQR=10.0) for PTSD symptoms, and 6.4 (SD=7.1)/4.0 (IQR=8.0) for anxiety symptoms.

Table 3.3 presents the association between each of the behavioral outcomes and injury status. Mean number of cigarettes smoked increased with number of injuries ($p=0.0473$) but not length of injury leave after adjustment by age, sex, and rank. Mean alcohol dependence scores were not associated with any injury variable. Poor sleep quality was significantly associated with injury occurrence ($p=0.0067$), number of injuries ($p=0.0105$), and length of injury ($p=0.0001$) after adjustment for age, sex, and rank. There were no associations with any of the behavioral outcomes and recency of injury.

When behavioral outcome scores were dichotomized using established clinical cut points, the prevalence of current smoking, alcohol dependence, and poor sleep quality was higher in participants in each of the injury categories but the 95% confidence intervals for the prevalence ratios included one (Table 3.4). The only significant association was found with poor sleep quality, where prevalence of having poor sleep quality was higher in participants who had four or more injuries compared to those with fewer than four injuries before and after adjustment by age, sex and rank ($p=0.0223$).

Table 3.5 presents the results of the mediation analysis. Injuries had a significant total ($b=0.5296$, $p=0.0055$) and direct effect on perceived stress ($b=0.3615$, $p=0.0439$). A significant proportion of this effect occurred indirectly through poor sleep quality (indirect effect=0.1681, $p=0.0194$). Similar findings occurred for PTSD and anxiety where injuries had a significant total effect (total effect for PTSD=0.9414, $p<0.0001$ and total effect for anxiety=0.4997, $p=0.0038$)

on these outcomes, as well as directly (directly for PTSD=0.7658, $p=0.0002$ and directly for anxiety=0.3231, $p=0.0418$) through poor sleep quality (indirect effect for PTSD=0.1756, $p=0.0435$ and indirect effect for anxiety=0.1766, $p=0.0158$). Injuries have a significant total effect on depression ($b=0.4508$, $p=0.0199$) and indirectly influences depression through poor sleep quality (indirect effect =0.1683, $p=0.0203$), but does not directly affect reported depression ($b=0.2375$, $p=0.1397$). Controlling for age, sex, and rank did not substantively change these results.

Table 3.1. Demographic characteristics of study participants by injury status. Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from day-to-day records, 1994-2009; N=430

Characteristics	Total n=430		No injury n=162		Any injury n=268		p-value ¹
	n	%	n	%	n	%	
Age							
<40 years	162	37.7	45	27.8	117	43.7	<0.0001
40-49 years	186	43.3	68	42.0	118	44.0	
≥50 years	82	19.1	49	30.3	33	12.3	
Sex							
Women	110	25.6	40	24.7	70	26.1	0.7423
Men	320	74.4	122	75.3	198	73.9	
Race							
White	331	78.1	129	81.7	202	75.9	0.2871
Black	86	20.3	26	16.5	60	22.6	
Ethnicity							
Hispanic	7	1.7	3	1.9	4	1.5	
Education							
≤High School/GED	50	11.7	20	12.4	30	11.2	0.3474
College <4 years	237	55.4	82	50.9	155	58.1	
College ≥4 years	141	32.9	59	36.7	82	30.7	
Marital Status							
Single	51	11.9	23	14.3	28	10.5	0.1528
Married	319	74.5	122	75.8	197	73.8	
Divorced	58	13.6	16	9.9	42	15.7	
Rank							
Patrol officer	292	68.7	83	52.2	209	78.6	<0.0001
Sergeant/Lieut/Capt	70	16.5	34	21.4	36	13.5	
Detective/Exec/Others	63	14.8	42	26.4	21	7.9	
Workload							
Low	19	4.6	9	5.8	10	3.8	0.6500
Moderate	131	31.4	49	31.4	82	31.4	
High	267	64.0	98	62.8	169	64.8	
Years of service							
0-9 years	105	24.5	39	24.1	66	24.7	<0.0001
10-14 years	89	20.8	13	8.0	76	28.5	
15-19 years	95	22.1	36	22.2	59	22.1	
>20 years	140	32.6	74	45.7	66	24.7	
Traumatic experiences before police work							
Yes	150	48.2	46	43.8	104	50.5	0.2652
No	161	51.8	59	56.2	102	49.5	

p-value: χ^2 or Fisher Exact Test in those with and without injury

Table 3.2. Prevalence of behavior characteristics of study participants by age, sex, and rank.
Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data
from payroll records, 1994-2009; N=430

Characteristic	Total n=430		Age <40 years n=268		Age ≥40 years n=162		Women n=110		Men n=320		Rank Patrol officer n=292		Rank Sergeant/Lieut/ Capt/Det/Other n=133	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Current smoking (>100 cigarettes lifetime)	69	16.2	32	20.0	37	13.9	28	26.2	41	12.9	53	18.3	16	12.0
Alcohol use (>12 drinks lifetime)	365	84.9	228	85.1	137	84.6	95	86.4	270	84.4	116	87.2	245	83.9
Alcohol dependence (AUDIT score ≥8)	108	25.5	50	31.9	58	21.8	18	16.5	90	28.7	75	26.1	33	25.2
Inadequate sleep (<7 hrs/24-hr period)	268	64.4	98	62.4	170	65.6	65	59.6	203	66.1	182	63.9	83	65.4
Poor sleep quality (PSQI >5)	217	54.0	81	52.6	136	54.8	60	56.1	157	53.2	149	54.2	67	54.5

Table 3.3. Linear Regression Coefficients of injury predictive of smoking (Crude and Adjusted).
BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	Smoking Number of cigarettes smoked/day n=69		Alcohol Dependence Global Alcohol Score-AUDIT n=422		Poor Sleep Quality Pittsburgh Sleep Quality Index Score n=402	
	Crude β (95%CI)	Adjusted ⁴ β (95%CI)	Crude β (95%CI)	Adjusted ⁴ β (95%CI)	Crude β (95%CI)	Adjusted ⁴ β (95%CI)
Injury Occurrence	-3.67 (-8.7,1.3)	-1.99 (-6.8,1.9)	0.17 (-0.65,0.98)	0.09 (-0.76,0.94)	0.86** (0.18,1.5)	0.99** (0.28,1.72)
Number of Injuries ²	0.82 (-0.19,1.8)	0.96* (0.01,1.9)	-0.04 (-0.22,0.14)	-0.07 (-0.26,0.11)	0.18* (0.03,0.34)	0.21* (0.05,0.37)
Length of Injury ^{2,3}	-0.383 (-1.9,1.2)	-0.086 (-1.5,1.4)	-0.085 (-0.35,0.18)	-0.11 (-0.38,0.15)	0.405** (0.19,0.62)	0.003** (0.22,0.67)
Recency of Injury	0.51 (-0.501,1.53)	-0.47 (-1.13,1.03)	-0.066 (-0.24,0.109)	0.015 (-0.166,0.195)	-0.069 (-0.21,0.073)	-0.113 (-0.26,0.035)

¹ Significance: *P<0.05, **P<0.01

² P-value: Linear regression-Trend test

³ Quartiles of injury leave

⁴ Adjusted for age, sex, and rank

Table 3.4. Prevalence ratios of smoking, alcohol use and poor sleep quality by number of injuries (Crude and Adjusted). BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	Current Smoking n=69		Alcohol Dependence AUDIT Score>7 n=422		Poor Sleep Quality PSQI Score>5 n=402	
	Crude PR (95%CI)	Adjusted ³ PR (95%CI)	Crude PR (95%CI)	Adjusted ³ PR (95%CI)	Crude PR (95%CI)	Adjusted ³ PR (95%CI)
One injury n=88	1.07 (0.63,1.80)	0.971 (0.58,1.63)	0.89 (0.58,1.36)	0.86 (0.57,1.30)	1.11 (0.91,1.37)	1.12 (0.91,1.38)
Two to three injuries n=108	1.16 (0.72,1.88)	1.11 (0.69,1.79)	1.14 (0.79,1.63)	1.18 (0.83,1.68)	1.03 (0.84,1.27)	1.0 (0.82,1.23)
Four or more injuries ¹ n=72	1.16 (0.67,2.0)	1.13 (0.66,1.96)	1.19 (0.80,1.79)	1.09 (0.72,1.63)	1.27* (1.1,1.56)	1.28* (1.1,1.57)

¹ Significance: *P<0.05

³ Adjusted for age, sex, and rank

Table 3.5. Bootstrapping results of direct and indirect effect of sleep quality on injuries and mental health outcomes, BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	β (95% CI)	SE	p
Perceived Stress ¹			
Total effect of injuries	0.5296 (0.16,0.90)	0.1897	0.0055
Direct effect of injuries	0.3615 (0.01,0.71)	0.1788	0.0439
Indirect effect of injuries through sleep quality	0.1681 (0.05,0.30)	0.0663	0.0194
Depression ¹			
Total effect of injuries	0.4058 (0.06,0.75)	0.1735	0.0199
Direct effect of injuries	0.2375 (-0.08,0.55)	0.1605	0.1397
Indirect effect of injuries through sleep quality	0.1683 (0.045,0.30)	0.0656	0.0203
PTSD ¹			
Total effect of injuries	0.9414 (0.52,1.38)	0.2156	0.0001
Direct effect of injuries	0.7658 (0.37,1.16)	0.2004	0.0002
Indirect effect of injuries through sleep quality	0.1756 (0.026,0.34)	0.0773	0.0435
Anxiety ¹			
Total effect of injuries	0.4997 (0.16,0.84)	0.1716	0.0038
Direct effect of injuries	0.3231 (0.012,0.63)	0.1582	0.0418
Indirect effect of injuries through sleep quality	0.1766 (0.049,0.33)	0.0704	0.0158

¹ Adjusted for age, sex, and rank

Discussion

Little research has looked at the burden of injury in first responders and its influence on substance use and sleep quality. This study sought to examine the association between prevalence, frequency, duration, and recency of duty-related injury and behavioral factors in U.S. police officers. More than half of the participants had experienced an injury, two-thirds of whom had experienced more than one duty-related injury, and the median number of days off due to an injury was 86, suggesting some of these injuries were severe. Approximately $\frac{3}{4}$ of the population

reported current alcohol use and ¼ met the screening criteria for alcohol dependence. Over half reported consistently getting less than 7 hours of sleep during a 24 hour period and met the screening criteria for poor sleep quality. Number of injuries increased with mean number of cigarettes smoked after adjustment by age, sex, and rank. Poor sleep quality was significantly associated with injury occurrence, number of injuries, and length of injury after adjustment for age, sex, and rank. Poor sleep quality mediated the effect of injury on adverse psychological outcomes after controlling for age, sex, and rank.

According to the U.S. Bureau of Statistics (2011), protective services occupations (including police officers, firefighters, correctional officers, and similar groups) had a median number of 12 days off due to a workplace injury compared to seven days off in private industry (BLS, 2011). On average, nearly 90% of line-of-duty police fatalities, and 50% of lost-time injuries were assault or vehicle related (Houser, 2004). The prevalence of injuries in this force was higher than has been observed in other studies of police officers and first responders (Leino et al., 2012; Reichard & Jackson, 2010).

Smoking prevalence in this population (16%) was lower than national estimates of 18% in the general population in 2012 (Agaku et al., 2014) and that reported for Milwaukee police officers in 2008 (32%) (Ramey et al., 2008). Women had a higher prevalence of smoking than men in this study and the prevalence for women was higher compared to national smoking estimates overall (16%) and across all age strata in women in 2012 (Agaku et al., 2014). These findings suggest that the injury may have been severe enough to lead to maladaptive coping behaviors. Current national surveillance has found higher smoking prevalence in those with

disabilities compared to the general population, which may be associated with smoking-attributable disability in smokers and increased stress associated with disabilities (Agaku et al., 2014; Borrelli et al., 2013).

Over 80% of officers reported current alcohol use, higher than that reported among full-time employed adults aged 18 or older (65%) in the 2010 national survey on drug use and health (SAMHSA, 2011). It was also higher than levels reported in other police and first responder populations (Fjeldheim et al., 2014). Consistent with current surveillance and research on alcohol use, alcohol dependence was higher in men than women (SAMHSA, 2011) but injury was not associated with alcohol dependence in this population. Alcohol use is common in law enforcement as evidenced by the high prevalence found in this study. Police culture reinforces the use of alcohol as a social and psychological device for coping with the stresses of the job (Violanti, 2003; Richmond et al., 1999). Other police studies have found that traumatic work exposures were associated with increased alcohol use (Violanti, 2004) while Leino and others found that frequent injuries were associated with increased alcohol use in Finish police officers (Leino et al., 2012). Given these findings, it is surprising that we did not find an association between alcohol dependence and injury here, but this lack of association may be accounted for by the overall high levels of consumption in this population. Individuals experiencing the most drinking-related functional impairment after injury may be more likely to leave the police force or level of alcohol use may not differ between individuals using it to cope with typical stressors in the line of duty compared to those who experienced an injury.

Police officers often are overly fatigued because of shift work, erratic work hours, and insufficient sleep, which can result in police officers being sleep-deprived throughout their entire career. Most research has focused on the effects of sleep-deprivation on decision making, and being sleep deprived in highly risky, unpredictable situations, and ultimately increasing vulnerability to injury in working populations (Violanti et al., 2013; Tiesman et al., 2006). While I am unable to control for prior sleep deprivation, I was able to document that injury (especially severe injury) may lead to increased frequency of poor sleep quality. Even with prior sleep deprivation, sustaining an injury may compound the issue leading to more sleep disturbances and increasing vulnerability to additional injury. Norwegian police officers who had experienced frequent injuries were found to have greater emotional exhaustion (Berg et al., 2006).

Sleep quality after an injury could be affected by the trauma associated with the injury episode and potentially related to pain after an injury. The finding that sleep quality mediated the relationship between injury and psychological conditions is in line with other studies that show poor sleep quality to be associated with both early and later onset of mental health disorders after injury (Holmes et al., 2014; O'Donnell et al., 2013; Norman et al., 2011; Asmundson et al., 1998; Schreiber & Galai-Gat, 1993). However, this study was limited in the ability to model these different directional mechanisms and possible interactions between injury, pain, and poor sleep. How these factors interact and lead to adverse mental health outcomes is complex. A bidirectional effect between sleep and psychological symptoms cannot be ruled out; especially as adverse psychological distress symptoms and conditions can lead to poor sleep quality.

An important limitation of the study is the absence of type, nature, or cause of injury from the day-to-day work history data. Behavioral effects likely differ with nature, cause, and type of injury and it would be important to examine the context in which the injury event occurred, as additional indicators of severity. The time lapse between injury occurrence and outcomes may have been too long, potentially 10-15 years prior to the time of the survey. However, researchers have found that behavioral and psychological distress symptoms often persist years after injury (Holmes et al., 2014; Malt, 1988). The lack of an observed association between injury and substance use could be due to underestimated smoking and alcohol use scores. As a group, police officers are known to be reluctant to report symptoms of distress, substance use and addiction, especially within their organization (Johnson et al., 2005; Miller, 2005; Lonsway et al., 2002; Richmond, et al. 1999). Other studies have identified the following predictors of poor mental health outcomes post injury: peri-traumatic dissociation and emotion, chronic pain, female sex, perceived threat to life, limited social support and financial resources, family history of psychopathology, and prior trauma (Prati & Pietrantonio, 2010; O'Donnell et al., 2008; Ozer, et al. 2003; Blackburn-Munro & Blackburn-Munro, 2001).

The potential for loss to follow-up for those who left the force prior to completing the BCOPS study and exclusion of those on long-term sick leave could have biased my results. An earlier comparison of demographic characteristics between participants and non-participants in the BCOPS study found that sex, age, rank, and year of hire did not differ (Hartley et al., 2011). The extent that these findings are generalizable to other law enforcement and first responder populations may be limited as the study includes participants from one city police department. Further research is needed that includes larger and more representative first responder

populations and detailed injury information to account for the variance in behavioral outcomes due to nature, cause and type of injury and a more complete understanding of the spectrum of disorders that affect functional outcomes after injury to minimize disability and maximize recovery.

Conclusion

Injury is a frequent occurrence among law enforcement with long periods of leave at times needed after experiencing an injury. Notably, this paper found that injuries were associated with increased smoking and poor sleep quality. Poor sleep quality may account for symptoms of psychological distress following injury for U.S. police officers. These findings shed light on the work-related injury experience and how it can lead to later adverse consequences in U.S. public safety workers. Effective occupational injury prevention strategies and interventions are needed to screen for and treat substance abuse and sleep deprivation, and later psychological outcomes in those who are injured. Particularly during times of economic hardship, decreased police budgets, and fewer police personnel, it is essential that adequate protection and treatment occurs among existing police personnel.

CHAPTER 4

Adverse psychological outcomes due to non-fatal injuries in police officers

Abstract:

Introduction: The mental health consequences of being injured on the job have not been well examined in first responders. This paper examines the prevalence, frequency, and duration of injury in association with depression, PTSD, and anxiety in police officers.

Methods: This cross-sectional study evaluates 430 active duty police officers from a mid-sized urban police department as part of an ongoing cohort study of police officers. On-duty injury was obtained from work histories covering the period 1994 to 2009 and all 430 police officers were invited to participate in the cohort study with enrollment occurring between 2004 and 2009. Measures of mental health included self-reported depression, PTSD, and anxiety. Bivariate and multivariate regression analyses were conducted controlling for potential confounders, comparing mental health outcomes in those with and without injury.

Results: Sixty-two percent of participants had experienced an injury; of those injured, 67% experienced more than one injury. The average number of days away from work due to the duty-related injury was 210 (range of 1-2250) and 41% of injured officers had taken more than 90 days off work. I found a statistically significant increasing trend in adjusted mean depression, PTSD, and anxiety scores with increasing injury count among the injured.

Conclusion: Results suggest repeated work-related injuries are psychologically distressing for U.S. police officers. These findings improve our understanding of the impact of injury in the line of duty for police. Specifically they suggest that work-related injury may lead to later psychological consequences in U.S. public safety workers.

Introduction:

Police work involves exposure to multiple critical incidents which can result in being seriously injured or killed. The most common nonfatal injuries among law enforcement are attributable to assaults, transportation incidents, and training incidents that result in sprains, strains, contusions, and abrasions (Reichard & Jackson, 2010; LaTourrette et al., 2008; Houser, 2004). Such incidents may occur more than once throughout an individual's work life. In 2008, as part of the Survey of Occupational Injuries and Illnesses (SOII), seven states reported information on nonfatal injuries and illnesses for state and local government workers. Police and sheriff's patrol officers had the highest frequency of injuries requiring days away from work compared to other responders (Brown, 2011).

In recent years, researchers have begun to demonstrate empirically the social and economic consequences of occupational injuries. Physical, psychological, social, and behavioral changes have been documented to occur in the aftermath of a moderate to severe occupational injury. Such changes also occur with repeated injuries even when they are less severe (Richmond & Kauder, 2000). An occupational injury can be thought of as a critical incident or traumatic event that can cause added pressure on career performance and tax an individual's emotional resources, resulting in a range of responses such as exhaustion or chronic mental health symptomology such as posttraumatic stress disorder (PTSD), depression, acute stress disorder, and anxiety (Maugen et al., 2009; O'Donnell et al., 2004, Kim, 2008). Overall recovery and later disability have been linked to level of psychological distress post injury (Richmond et al., 2003; Zatzick et al., 2002b). A study that examined depression, PTSD, and anxiety as sources of disability for injured patients found psychological symptoms contributed more to enduring disability at 12 months than physical limitations (O'Donnell et al., 2013). Long-term financial

hardship, limited ability to perform activities of daily living, and shifts in family dynamics associated with loss of income and disability can add to the emotional and physical burdens that accompany injuries (Strunin & Boden, 2004; Dembe, 2001; Pransky et al., 2000).

An accumulation of organizational, operational, and interpersonal pressures has been shown to lead to burnout, PTSD, depression, and anxiety in police (McFarlane et al., 2009; Violanti, 2004; Robinson et al., 1997). However, few studies have examined injury as a risk factor for chronic psychological symptoms in this population. Some research has looked at the effect of traumatic injury in combat veterans. Koren et al. found injured veterans were 2-3 times more likely to report PTSD than those who were not injured during combat although the context differs in important ways from experiencing an injury during civilian life (Koren et al., 2005). Carty and colleagues (Carty et al., 2005) demonstrated that a large proportion of injured victims, initially hospitalized, were diagnosed with delayed onset PTSD 12 months after the event, suggesting risk of psychological morbidity may be delayed due to ongoing physical disability and limited available resources following traumatic injury (Carty et al., 2006). Injured patients are more likely to commit suicide than the general population, an extreme indicator of the impact of PTSD, depression, and other psychiatric comorbidity (Ryb et al., 2006). PTSD and depression are common after an injury, with 10 to 20% of injured patients meeting diagnostic criteria for PTSD and depression (O'Donnell et al., 2004).

This paper examines the association of duty-related injury, including frequency, duration, and recency of injury leave, with symptoms of depression, PTSD, and anxiety in police officers. An additional aim is to identify risk factors related to injury that increase the likelihood of psychological distress symptoms. Identifying these factors resulting from traumatic and non-

traumatic injury will aid in development of primary and secondary prevention strategies in first-responder groups.

Methods

This cross-sectional study of active duty police officers from a mid-sized urban police department is part of an ongoing larger cohort study, the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study designed to examine the effects of stress and policing on mental and physical health. All 810 officers working as of 2004 in the department were invited to participate in the BCOPS study during the period of May 21, 2004 to October 2, 2009. To be included in the BCOPS study a participant had to be an active sworn police officer, not on long-term leave, and not pregnant. One hundred officers who were on extended leave due to illness, disability or suspension and 2 pregnant officers were excluded. An additional 110 officers did not participate due to retirement, leaving the police force, or death while 134 chose not to participate. This yielded a sample of 464 officers who participated in the for the BCOPS study (Violanti et al., 2006). Participants completed questionnaires and were interviewed once between 2004-2009 providing information on psychological outcomes as well as on demographic characteristics, lifestyle behaviors, and health history.

Payroll work history data were obtained to assess occurrence of on-duty injury from 1994 to 2009 for each participating officer (injured and uninjured). The work history data contained a day-by-day account of activities for each officer including shifts, activity type (regular time work, court work or overtime work), leave, sickness and injury information, and the specific hours worked. An on-duty injury was defined when the payroll record indicated that an officer was paid for regular work but was on disability leave due to on-duty injury. Payroll work history

data were available for 430 of the 464 BCOPS study participants and thus eligible for this analysis.

For each subject, injuries from the work history data that occurred prior to the date of questionnaire completion in the BCOPS study were included. Each continuous leave period due to on-duty injury was defined as one injury event. From this, a binary variable was constructed for ever having been injured (yes/no). An officer was at risk for developing a new injury following a full day of regular time at work after a previous injury. Using this definition, the number of injuries for each participant was calculated and categorized as one injury, two to three injuries, or three or more injuries from 1994-2009. The total number of days, including weekends that a participant was on leave due to on-duty injury was summed to obtain the total length of injury leave period for each participant. Of these injury leave periods, I used the injury leave period with the longest continuous duration of days on disability leave to define duration of injury. I also categorized duration of injury as less than 30 days, 30 to 89 days, and 90 or more days. The variable, recency of injury, was based on the time interval from most recent injury to date of questionnaire completion. The continuous and categorized version of this variable was used with the categories being less than one year, one to two years, two to three years, three to five years, and five or more years. Thus, the four injury variables assessed here include: injury occurrence, number of injuries; duration of injury, and recency of injury.

Depressed mood was measured using the 20-item Center for Epidemiologic Studies Depression (CES-D) scale. Respondents rated items on a 4-point scale based on the frequency of symptom occurrence in the previous seven days: 0 (rarely or none of the time, less than 1 day), 1 (some or little of the time, 1-2 days), 2 (occasionally or a moderate amount of time, 3-4 days), and 3 (most of the time, 5-7 days). The summed item-score ranges from 0 to 60. A score of 16 or

higher is considered indicative of depressed mood (yes/no) (McDowell & Newell, 1996; Radloff, 1977). The CES-D has shown acceptable internal consistency (Cronbach alpha of .85) and a split-half reliability ranging from .76 to .85 in other studies.

PTSD was measured using the 17-item PTSD Checklist-Civilian Version (PCL-C), which has been validated in adult populations (Sandweiss et al. 2011; Brewin, 2005; Blanchard et al., 1996). Participants were screened as having PTSD symptoms based on their report of the three criteria: intrusion—recurrent and intrusive recollections of the event, avoidance-detachment and efforts to avoid thoughts, feelings of event, and hyperarousal-difficulty sleeping and concentrating, hypervigilance. Full PTSD, according to the DSM-IV criteria, was defined as scores equal or higher than three on at least one symptom of re-experiencing, on at least three symptoms of avoidance and numbing and on at least two symptoms of hyperarousal. Partial PTSD was also defined when individuals fulfilled criteria for at least two out of the three symptom clusters defined by the DSM-IV (APA 2000); this definition has been used in previous studies on traumatic stress in police personnel (Carlier et al., 1997). The dichotomous variable for PTSD was created by combining partial and full PTSD compared to not or mild PTSD.

The Beck Anxiety Inventory (BAI) was used to measure anxiety (Beck et al., 1988). The respondent was asked to score 21 common symptoms of anxiety in the past 2 weeks. The BAI is used to evaluate anxiety symptom severity with the cutoff indicating minimal (0-7), mild (8-15), moderate (16-25), and severe (26-63) symptom presentation. I created a dichotomous variable (moderate and severe anxiety versus no or mild anxiety). The BAI demonstrates high internal reliability and good factorial and discriminant validity (Kabacoff et al., 1997). The internal consistencies of constructs for this study were assessed with Cronbach alpha; depression using the CES-D: 0.86, PTSD using the PCL-C: 0.91, and anxiety using the BAI: 0.88.

Age, sex, race/ethnicity, marital status, and work characteristics were measured through interviews and self-administered questionnaires. Work characteristics included rank, working hours, and years of service. Rank was collapsed into three categories: patrol police, sergeant/lieutenant, and captain/detective/executive/others. Traumatic history was measured using a question that asked if participants had any previous traumatic experience prior to coming into police work.

Data collection was performed at The Center for Health Research, State University of New York at Buffalo. The BCOPS study was approved by the Internal Review Board of the State University of New York at Buffalo and the Human Subjects Review Board of the National Institute for Occupational Safety and Health. Analyses for this paper were approved by the Health Sciences and Behavioral Sciences Institutional Review Boards at the University of Michigan.

Statistical Analysis

I examined distributions of each variable and compared demographic and work characteristics of participants with and without injury and by mean values of depression, PTSD, and anxiety. Student *t*-tests and analysis of variance (ANOVA) were used to compare mean values of continuous variables by category of injury and chi-square tests were used to examine the relationships between categorical covariates. I used multivariable linear regression to examine the association of injury with continuous scores for CES-D, PTSD, and anxiety variables adjusted for possible confounders. For linear regression models, continuous versions of the injury variables were used. Log-binomial models were fitted to determine associations between injury and dichotomous forms of CES-D, PTSD, and anxiety using established clinical

cut points while adjusting for possible confounders. Adjusted prevalence ratios were generated using SAS Genmod procedure and COPY method for common outcomes (Deddens & Petersen, 2008). Unadjusted and adjusted means and prevalence ratios were calculated. Inclusion of select covariates in multivariate regression models was based on results of initial bivariate analyses and previously published literature. Separate models were tested for each of the four injury variables with each of the three psychological outcomes. I used a sequential modeling approach where models are 1) unadjusted and 2) adjusted for age, sex, and rank, and 3) adjusted for age, sex, rank, and traumatic experience before police work. Twelve models were tested but only unadjusted and fully adjusted models are presented for this paper. Statistical significance was assessed for all tests at the 5% level. All analyses were performed using SAS 9.3 (SAS institute, Cary, NC, USA).

Results

Demographic and lifestyle characteristics of study participants by injury status are shown in Table 4.1. Overall, most of the participants were male (74%) with an average age of 43 years (range 27-70). A larger proportion of those who had experienced a duty-related injury were younger, had fewer years of service, and were a patrol officer.

Nearly two-thirds (62%) of the participants had experienced an injury. Of those who were injured, 67% experienced more than one duty-related injury with the average number of 3 injuries (range 1-12). The average number of days on leave due to a duty-related injury was 210 (range of 1-2250). Duration of injury leave varied, but 41% of participant had more than 90 days away from work due to duty-related injury. When I examined recency of injury, 29% had the last

injury within one year and 24% had the last injury in 5 or more years prior to the time of questionnaire completion.

The overall mean/median scores of the psychological outcomes in this sample were 7.8 (SD=6.9)/6.0 (IQR=7.5) for depressive symptoms, 26.3 (SD=8.9)/24.0(IQR=10.0) for PTSD symptoms, and 6.4 (SD=7.1)/4.0 (IQR=8.0) for anxiety symptoms. Twelve percent (n=49) of participants met the definition of depressive mood, 17% (n=64) met the definition for partial or full PTSD symptoms, and 31% (n=129) met the definition for mild, moderate or severe anxiety symptoms. Table 4.2 presents the mean scores of depression, PTSD, and anxiety symptoms by demographic characteristics. Women had higher mean anxiety symptom scores than men. Higher mean depression and PTSD symptom scores were observed in those who reported traumatic experiences before police work.

Table 4.1. Associations of demographic, lifestyle, and work history characteristics of study participants with injury status. Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from day-to-day records, 1994-2009; N=430

Characteristics	Total n=430		No injury n=162		Any injury n=268		p-value ¹
	n	%	n	%	n	%	
Age							
<40 years	162	37.7	45	27.8	117	43.7	<0.0001
40-49 years	186	43.3	68	42.0	118	44.0	
>50 years	82	19.1	49	30.3	33	12.3	
Sex							
Women	110	25.6	40	24.7	70	26.1	0.7423
Men	320	74.4	122	75.3	198	73.9	
Race							
White	331	78.1	129	81.7	202	75.9	0.2871
Black	86	20.3	26	16.5	60	22.6	
Ethnicity							
Hispanic	7	1.7	3	1.9	4	1.5	
Education							
≤High School/GED	50	11.7	20	12.4	30	11.2	0.3474
College <4 years	237	55.4	82	50.9	155	58.1	
College ≥4 years	141	32.9	59	36.7	82	30.7	
Marital Status							
Single	51	11.9	23	14.3	28	10.5	0.1528
Married	319	74.5	122	75.8	197	73.8	
Divorced	58	13.6	16	9.9	42	15.7	
Rank							
Patrol officer	292	68.7	83	52.2	209	78.6	<0.0001
Sergeant/Lieut/Capt	70	16.5	34	21.4	36	13.5	
Detective/Exec/Others	63	14.8	42	26.4	21	7.9	
Workload							
Low	19	4.6	9	5.8	10	3.8	0.6500
Moderate	131	31.4	49	31.4	82	31.4	
High	267	64.0	98	62.8	169	64.8	
Years of service							
0-9 years	105	24.5	39	24.1	66	24.7	<0.0001
10-14 years	89	20.8	13	8.0	76	28.5	
15-19 years	95	22.1	36	22.2	59	22.1	
>20 years	140	32.6	74	45.7	66	24.7	
Traumatic experiences before police work							
Yes	150	48.2	46	43.8	104	50.5	0.2652
No	161	51.8	59	56.2	102	49.5	

¹p-value: χ^2 or Fisher Exact Test in those with and without injury

Table 4.2. Associations of demographic, lifestyle, and work history characteristics of study participants with CES-D1, PTSD2, and Anxiety Scores. Buffalo Cardio-metabolic Occupational Police Stress (BCOPS) Study, 2004-2009, Injury data from day-to-day records, 1994-2009; N=430

Characteristics	CES-D score n=427			PTSD score n=380			Anxiety score n=416		
	n	Mean \pm SD	p-value ¹	n	Mean \pm SD	p-value ¹	n	Mean \pm SD	p-value ¹
Age									
<40 years	162	8.4 \pm 7.3	0.3488	151	26.1 \pm 9.2	0.9235	159	7.1 \pm 7.7	0.2358
40-49 years	185	7.4 \pm 6.9		164	26.4 \pm 8.8		183	5.8 \pm 6.1	
>50 years	80	7.5 \pm 5.9		65	26.6 \pm 8.4		74	6.5 \pm 7.8	
Sex									
Women	109	8.9 \pm 8.1	0.0625	102	27.1 \pm 9.1	0.2968	106	9.0 \pm 8.4	<.0001
Men	318	7.4 \pm 6.4		278	26.0 \pm 8.8		310	5.5 \pm 6.3	
Race									
White	331	8.0 \pm 7.0	0.3083	290	26.8 \pm 9.2	0.1268	320	6.7 \pm 7.3	0.1966
Black	83	6.7 \pm 6.6		81	24.5 \pm 7.6		84	5.2 \pm 6.3	
Hispanic	7	7.9 \pm 4.3		4	25.3 \pm 2.2		7	6.7 \pm 3.5	
Education									
\leq High School/GED	50	7.4 \pm 6.0	0.7409	45	27.0 \pm 9.9	0.8074	20	5.9 \pm 6.7	0.4513
College <4 years	235	7.6 \pm 6.7		210	26.3 \pm 8.5		229	6.8 \pm 7.5	
College \geq 4 years	140	8.1 \pm 7.5		123	26.0 \pm 9.1		136	5.9 \pm 6.4	
Marital Status									
Single	50	8.2 \pm 6.8	0.3303	49	27.7 \pm 10.3	0.3632	48	7.4 \pm 8.1	0.5621
Married	317	7.5 \pm 6.6		275	25.9 \pm 8.3		310	6.3 \pm 7.0	
Divorced	58	8.9 \pm 8.5		54	27.1 \pm 10.3		57	6.2 \pm 6.4	
Rank									
Patrol officer	289	7.5 \pm 6.6	0.3113	278	25.9 \pm 8.8	0.2370	285	6.7 \pm 7.5	0.3217
Sergeant/Lieut/Capt	70	8.7 \pm 8.2		49	27.9 \pm 8.9		67	6.2 \pm 5.8	
Detective/Exec/Others	63	8.5 \pm 6.8		50	27.2 \pm 9.2		60	5.2 \pm 6.4	
Workload									
Low	19	8.3 \pm 8.2	0.7649	15	25.0 \pm 8.0	0.5110	18	6.5 \pm 6.1	0.6926
Moderate	130	7.4 \pm 6.3		117	27.0 \pm 8.9		125	6.8 \pm 6.8	
High	265	7.8 \pm 6.9		238	26.0 \pm 8.9		261	6.2 \pm 7.2	
Years of service									
0-9 years	105	7.2 \pm 5.6	0.2992	103	25.6 \pm 8.3	0.7375	102	6.2 \pm 7.1	0.4413
10-14 years	89	8.7 \pm 8.3		82	26.7 \pm 9.3		88	7.3 \pm 6.9	
15-19 years	94	8.4 \pm 7.7		85	26.9 \pm 10.2		94	6.7 \pm 7.2	
>20 years	138	7.3 \pm 6.3		109	26.1 \pm 7.9		132	5.8 \pm 7.1	
Traumatic experiences before police work									
Yes	150	8.7 \pm 7.5	0.0152	144	27.7 \pm 9.6	0.0302	145	7.4 \pm 7.3	0.0557
No	161	6.9 \pm 6.0		157	25.4 \pm 8.5		159	5.8 \pm 6.6	

¹p-value: χ^2 of psychological symptoms by levels of covariates

²Center for Epidemiologic Studies Depression Scale

³Posttraumatic stress disorder checklist

⁴Beck Anxiety Inventory

Table 4.3 presents the association between each of the psychological symptom outcomes and injury status. CES-D symptoms were not associated with any injury variable. Although PTSD symptoms were not associated with injury occurrence, they were associated significantly with number of injuries even after adjustment for age, rank, sex, and traumatic history. Anxiety symptoms were associated with injury occurrence and length of injury but not after adjusting for age, rank, sex and traumatic history. Anxiety symptoms were associated with number of injuries and these associations remained statistically significant when the model was adjusted for age, rank, sex, and traumatic history. No statistically significant linear trend was found between CESD and anxiety scores and recency of injury. However, after analyzing each of the outcomes with categories of recency of injury leave, a statistically significantly higher mean PTSD score was found for those with injury leave within 1 to 2 years of completing the baseline questionnaire compared to those with no injury ($p=0.0177$) after adjustment.

Table 4.3: Linear Regression Coefficients of CES-D, PTSD, and Anxiety Symptom Scores (Crude and Adjusted). BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	CES-D score n=427				PTSD score n=380				Anxiety score n=416			
	Crude		Adjusted ³		Crude		Adjusted ³		Crude		Adjusted ³	
	β (95%CI)	R ²	β (95%CI)	R ²	β (95%CI)	R ²	β (95%CI)	R ²	β (95%CI)	R ²	β (95%CI)	R ²
Injury Occurrence	0.305 (-1.1,1.7)	0.0005	0.347 (-1.3,2.0)	0.06	1.69 (-0.18, 3.6)	0.008	2.09 (-0.21,4.4)	0.05	1.44* (0.04, 2.8)	0.01	1.46 (-0.24, 3.2)	0.09
Number of Injuries ²	0.284 (-0.03,0.60)	0.007	0.284 (-0.07,0.63)	0.07	0.744*** (0.33, 1.2)	0.03	0.816*** (0.34,1.3)	0.07	0.459** (0.14, 0.78)	0.02	0.535** (0.18,0.89)	0.103
Length of Injury ²	0.001 (-0.003,0.005)	0.0007	0.001 (-0.003,0.005)	0.06	0.004 (-0.001,0.009)	0.005	0.003 (-0.002,0.009)	0.04	0.004* (0.0002,0.008)	0.010	0.004 (-0.0007,0.008)	0.08
Recency/Proximity of Injury to survey period ²	-0.221 (-0.52,0.08)	0.008	-0.037 (-0.40,0.33)	0.07	-0.258 (-0.67,0.16)	0.006	-0.102 (-0.63,0.43)	0.04	-0.136 (-0.45,0.18)	0.003	-0.101 (-0.47,0.27)	0.14

¹Significance: *P<0.05, **P<0.01, ***P<0.001

²P-value: Linear regression-Trend test

³Adjusted for age, sex, rank, and traumatic experiences before police work

When psychological symptom scores were dichotomized using established clinical cut points, the prevalence of having depressed mood was higher in participants who had four or more injuries compared to those with less than four injuries but the 95% confidence intervals for the prevalence ratios included one (Table 4.4). The prevalence of having partial or full PTSD and anxiety symptoms was higher in participants who had two or more injuries compared to those with less than two injuries but the 95% confidence intervals for the prevalence ratios also included one (Table 4.4). The only statistically significant association was found between participants who had four or more injuries and anxiety symptoms, where they were 2.5 times more likely to report moderate to severe anxiety symptoms after adjusting for age, sex, rank, and traumatic experiences before police work.

Table 4.4: Unadjusted and adjusted prevalence ratios of CES-D, PTSD, and Anxiety Symptom Score cutoffs by injury leave. BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	CES-D Score \geq 16 N=427		PTSD Partial or Full N=380		Anxiety Score \geq 16 N=416	
Risk factor	Crude PR (95% CI)	Adjusted ² PR (95% CI)	Crude PR (95% CI)	Adjusted ² PR (95% CI)	Crude PR (95% CI)	Adjusted ² PR (95% CI)
One injury ¹ n=88	1.13 (0.60, 2.1)	1.35 (0.67, 2.7)	0.75 (0.41, 1.4)	0.83 (0.43, 1.6)	0.67 (0.31, 1.4)	0.46 (0.17, 1.2)
Two to three injuries ¹ n=108	0.87 (0.46, 1.6)	0.75 (0.34, 1.7)	1.47 (0.92, 2.3)	1.14 (0.66, 2.0)	1.45 (0.82, 2.6)	1.33 (0.68, 2.6)
Four or more injuries ¹ n=72	1.62 (0.89, 2.9)	1.74 (0.9, 3.6)	1.08 (0.61, 1.9)	1.09 (0.58, 2.1)	1.95* (1.1, 3.5)	2.51** (1.3, 4.9)

¹Significance: Wald test *P<0.05, **P<0.01

²Adjusted for age, sex, rank, and traumatic experiences before police work

Discussion

This is one of the first studies to examine the association between prevalence, frequency, duration, and recency of duty-related injury and psychological distress symptoms in U.S. police officers. Notably, more than half of the participants had experienced an injury, two-thirds of whom had experienced more than one duty-related injury. I found that younger officers and patrol officers experienced more injuries. Younger officers may engage in riskier behaviors that can lead to injuries. Patrol officers may encounter more situations that place them at higher risk of injury than officers in other capacities. Suspecting that there could be some correlation of rank and age, I examined and found variability of age in rank; specifically, 42% of the patrol officers were over the age of 40. However, age and years of service were strongly correlated in this sample.

The prevalence of injuries in this force was higher than has been observed in other studies of police officers and first responders (Leino et al., 2012; Reichard & Jackson, 2010). Injury experience was associated with prevalence and severity of anxiety and PTSD but not depressed mood. Anxiety scores were higher on average in officers who had taken injury leave. Repeated injury leave was associated with having PTSD and anxiety.

My findings that anxiety and PTSD were associated with prior injury are consistent with previous studies; however, some studies found an association with depression where I did not. The occurrence of traumatic life events has been found to be associated with a high prevalence of depression in police officers (Hartley et al., 2007). In a study of UK police officers, investigators found injury during operational incidents was related to high levels of psychological distress including depression (Brown et al., 1999). In a study of World Trade Center disaster rescue

workers, and police after hurricane Katrina, experiencing an injury was found to be a risk factor for depression and PTSD (West et al., 2008; Perrin et al., 2007).

Other studies suggest a dose-response effect of work injuries and level of psychological distress as I have found, including in police populations. Finnish and Norwegian police officers who had experienced frequent injuries were found to have higher prevalence of adverse mental health outcomes (Leino et al., 2012) and emotional exhaustion (Berg et al., 2006). Another study found greater emotional instability, depressive and anxiety symptoms in injured compared to uninjured workers and concluded that the psychological consequences for workers who return to, or remain at, work following injury may reduce adaptation and increase vulnerability to secondary work disability (Wall, 2008). In my study, I was unable to differentiate if participants were taking leave due to a new or an existing injury that may have been aggravated during duty and required the officer to take additional separate injury leave. Finding an association with these repeated injury events, could mean that officers were more vulnerable to a repeat injury or that if could have been due to the same injury that was particularly severe. In addition, PTSD symptoms were affected by time since participant's last injury leave. This analysis also found that participants reported PTSD symptoms up to 2 years after the injury event suggesting that officers may be affected by the injury for an extended period and may need monitoring and care for potential psychiatric consequences for an extended period of time (Holmes et al., 2014; Bryant et al., 2010). The effects of injury may be underestimated for periods longer than 2 years.

The association between injury and each of the psychological symptoms was weak: <10% of the variance of symptoms was explained by injury. The inclusion of socio-demographic variables in the models increased their predictive value. There are likely many other factors that are contributing to psychological symptoms in this population. In addition to job tasks that are

potentially life threatening, police stress research has found organizational stressors, such as equipment not working, daily operational hassles, being unclear about work roles, stressful relationships with coworkers, inadequate department support, shift work, long working hours, or feelings of discrimination, as a source of poor mental health outcomes (Maguen et al., 2009; Collins & Gibbs, 2003; Carlier et al., 1997; Violanti & Aron, 1995). The lack of association between injury and psychological distress symptoms could be due to underestimated psychological distress symptom scores. As a group, police officers are known to be reluctant to report symptoms of distress (Johnson et al., 2005; Miller, 2005; Policing, 2002).

I had hypothesized that officers with longer leave periods due to injury would have higher psychological distress symptom scores. Mean depression, PTSD, and anxiety scores were higher with increasing number of days compared to those without injury but the association was not statistically significant. Lower PTSD, depression, and anxiety levels were reported among participants with 500 or more days of leave (n=10) which could represent a special circumstance in the officer's career where the injury would not be considered as psychologically distressing. In my analyses I found these points exerted some leverage so I examined the association when those with 500 or more days of leave were excluded. Excluding these individuals, the adjusted association between length of leave due to injury and depression, PTSD, and anxiety symptoms was statistically significant.

Other studies have identified the following predictors of poor mental health outcomes post injury: peri-traumatic dissociation and emotion, chronic pain, female sex, perceived threat to life, limited social support and financial resources, family history of psychopathology, history of maladaptive coping responses, and prior trauma (Prati & Pietrantonio, 2010; O'Donnell et al., 2008; Ozer et al., 2003; Blackburn-Munro & Blackburn-Munro, 2001). Further studies should

examine these factors as predictors and mediators when examining the association between injury and psychological health outcomes in police officers.

An important limitation of the study is the absence of type, nature, or cause of injury from the day-to-day work history data. Psychological distress symptom effects likely differ with nature, cause, and type of injury and it would be important to examine the context in which the injury event occurred, i.e., the nature, cause, and type of the injury as additional indicators of severity. However, some research has found that objective severity of physical injury is not related to occurrence or severity of postinjury psychological consequences, as even minor injuries can lead to traumatic stress responses (Zatzick et al., 2002b; Dougall et al., 2001; Schnyder et al., 2001; Richmond & Kauder, 2000). Although the associations were trending toward significance, they didn't achieve statistical significance which may suggest this study did not have sufficient power to look at these relationships. Further research is needed that includes larger and more representative first responder populations and detailed injury information to account for the variance in psychological outcomes due to nature, cause and type of injury.

The potential for loss to follow-up for those who left the force prior to completing the BCOPS study and exclusion of those on long-term sick leave could have biased my results. An earlier comparison of demographic characteristics between participants and non-participants in the BCOPS study found that sex, age, rank, and year of hire did not differ (Hartley et al. 2011). The extent that these findings are generalizable to other law enforcement and first responder populations may be limited as the study includes participants from one city police department. Although there is a potential for reverse causation given the absence of concurrent health and injury information leading to increased risk of occupational injury, adjusting for past traumatic history did not change my overall conclusion.

Conclusion

This paper suggests that injury is a frequent occurrence in law enforcement with long periods of leave needed after experiencing an injury. Notably, injury and repeated injury were associated with PTSD and anxiety symptoms. These findings shed light on the work-related injury experience and how it can lead to later psychological consequences in U.S. public safety workers. Future studies are needed to better examine the psychological consequences of injury in public safety workers. Effective occupational injury prevention strategies and interventions to treat/screen psychological symptom development in those who are injured are needed. These interventions and further monitoring for PTSD need to occur for an extended period of time, as my research suggests that officers are reporting PTSD symptoms beyond 1 year.

CHAPTER 5

Discussion

Overview of Findings

This research sought to examine the impact of duty-related injury on perceived stress, unhealthy behaviors, and mental health outcomes and their inter-relationships in police officers. Overall, work-related injury was common in this sample with most injured officers taking extended time off for their injuries. Nearly two-thirds (62%) of the participants had experienced an injury and 67% experienced more than one duty-related injury. The median number of days on leave due to a duty-related injury was 86 (range of 1-2250). Duration of injury leave varied, but 41% of participants had more than 90 days away from work due to duty-related injury during the study period. When I examined recency of injury, 53% had experienced their last injury in the last 5 years prior to the time of questionnaire completion.

Half of the population reported high stress levels, 12% reported depressed mood, 17% reported partial or full PTSD, and 31% reported anxiety symptoms. After controlling for age, rank, and sex, perceived stress scores were higher in injured compared to not-injured participants but the difference was not statistically significant. However, mean level of perceived stress did differ by injury count even after adjustment for age, rank, and sex. Mean perceived stress scores increased with duration of injury leave after adjusting for age, rank, and sex, but these differences were also not statistically significant.

Of the study participants, 16% reported they were current smokers; approximately three-quarters of the population reported current alcohol and one-quarter met the screening criteria for

alcohol dependence. Over half reported consistently getting less than 7 hours of sleep during a 24 hour period and met the screening criteria for poor sleep quality. Smoking and alcohol dependence were not associated with injury occurrence or number of injuries. A statistically significant positive trend was found between number of injuries and length of injury leave with mean number of cigarettes smoked after adjustment by age, sex, and rank. Poor sleep quality was significantly associated with injury occurrence, number of injuries, and length of injury after adjustment for age, sex, and rank. Although trending in the hypothesized direction, injury occurrence was not found to be associated with depression, PTSD, or anxiety after adjusting for age, rank, sex, and traumatic history. I found a statistically significant increasing trend in adjusted PTSD and anxiety scores with increasing injury count among the injured. Participants who had four or more injuries were 2.5 times more likely to report moderate to severe anxiety symptoms after adjustment. Poor sleep quality was found to mediate the effect of injury on adverse psychological outcomes after controlling for age, sex, and rank.

A major finding from this research was that repeated work-related injuries were associated with increased psychological distress in U.S. police officers although injury occurrence per se was not found to be related to perceived stress, depression, PTSD, and anxiety score after adjustment. Higher mean perceived stress was reported in those with higher number of days of leave, but the association was not statistically significant which was surprising. Lower distress levels were reported in participants with 500 or more days of leave (n=10), which could represent a special circumstance in those officers' careers where the injuries were not as psychologically distressing. When those with 500 or more days of leave were excluded, the adjusted association approached statistical significance for perceived stress and was significant for greater depression, PTSD, and anxiety. Over half of the sample experienced their last injury

within 5 years prior to the time mental health and behavioral factors were measured, those with injury leave in the last 1-2 years of assessment had higher mean stress and PTSD scores than those with no injury. Thus, it may be more meaningful to measure these outcomes closer to the time the injury occurred.

Strengths and Limitations

Strengths of the study include the use of comprehensive exposure information from an existing cohort of police officers, availability of objective recording of injury and other work schedules. Given this is administrative data, underreporting of injuries may not be a problem but some minor cases may still be missed if they didn't require an officer to be on leave for the day. The study also used reliable and valid screening tools to measure multiple occupational, social, and psychological outcomes in this population, use of standardized protocols for collection of data, and high response rates and cooperation in the study. To my knowledge, this is the first study to document descriptive patterning of injury and the association of stress and stress-related outcomes in a first responder population. The choice to examine law enforcement, an inherently stressful occupation, as the study sample allowed in some cases for larger effect sizes to study the risk factors for psychological outcomes.

One of the major limitations of the study is the absence of type, nature, or cause of injury from the payroll work history data. Psychological effects likely differ with type and nature of injury and it would be useful to describe these other injury characteristics that occur in this population. Information that will help to examine these associations will be available as part of the second full exam for the BCOPS study currently in progress, which will include data from a

detailed injury history questionnaire and work history data. Another limitation of this study is the potential selective loss to follow-up for the first exam, and exclusion of those on long-term sick leave; this could result in biased effect estimates. An earlier comparison of demographic characteristics was conducted between participants and non-participants by BCOPS researchers; they found similar frequency distributions for sex, age, rank, and year of hire. This comparison included 95% of the officers included in this analysis (Hartley et al., 2011). The extent that these findings are generalizable to other law enforcement and first responder populations may be limited as the study includes participants from one city police department.

Small sample sizes limited detection of differences and interactions, information on non-duty injury was not collected, and use of self-reported data from questionnaires is a further potential limitation. Small effect sizes for depression could have led to a lack of association found in this study and lack of normality of the depression variable distribution. PTSD or anxiety rather than depression after an injury may be more common if the injury was particularly traumatic. However, depression frequently co-occurs with other psychiatric conditions where individuals who experience a traumatic event frequently develop both depression and PTSD (NIMH, 2008; Shalev et al., 1998).

Another important limitation is potential for reverse causation due to the lack of baseline data on mental health and injury. Given this lack of baseline data along with the absence of concurrent health and injury information, we cannot rule out the alternative explanation that stress leads to increased risk of occupational injury. Studies that have examined adverse mental health symptoms as risk factors for injury, or depression as an outcome of injury, have largely been cross sectional, making it difficult to determine which occurred first—the injury or the psychological symptoms. I was limited in the ability to model these different directional

mechanisms and possible interactions between injury, pain and poor sleep. How they may lead to adverse mental health outcomes is complex. A bidirectional relationship could exist between sleep and psychological symptoms and it is plausible that adverse psychological distress symptoms and conditions would have led to poor sleep quality. Ultimately, physical and psychiatric sequelae are not independent and complex interactions occur between injury, risk of re-injury, mental health, and enduring disability over time and require longitudinal assessment.

Public Health Implications for Policy and Programs

This research strengthens our understanding of injuries and the association with mental health in a public safety occupation. Injury leave was lengthy, repeated injury was common, and findings suggest injury experience was a stressor with chronic mental and behavioral health symptoms associated in this group. The research highlights the need to look at the circumstances surrounding the injuries and their influence on mental health outcomes. Much of the information collected by official sources on injuries has relied on injuries sustained due to assaults and other violence related exposures; this research suggests that minor, more frequent injuries may be contributing to these outcomes and warrants further investigation to target modifiable risk factors and early treatment to prevent ongoing disability.

Future policy efforts should focus on examining and developing early interventions that target mental health care along with treating physical and pain consequences of injury. Given that officers are having repeated injuries, it is incumbent upon management and the health community to intervene early to prevent injuries and their sequelae to prevent subsequent injuries. Currently, training and wellness programs are being offered on a federal, state and local level for law enforcement personnel. The five core components of wellness programs are

physical fitness, stress management, psychological and mental health, nutrition and dietary related issues, and alcohol and chemical dependency with the goal of decreasing health care costs, turnover, employee injury, disability payments, and absenteeism (Parks & Steelman, 2008; Church & Robertson, 1999). Few ongoing mandatory fitness programs and readiness standards are required but some departments have voluntary health and fitness programs.

Of the mental health treatment options, employee assistance programs and critical incident stress debriefing are common programs used by police departments in an attempt to reduce stress related disorders such as PTSD. However, research indicates that there is resistance to use of these services by police groups. This resistance can be explained in part by the perceived lack of confidentiality and the stigma associated with mental health or psychiatric treatment within the field of law enforcement (Wester et al., 2010; Violanti, 2007; Amaranto et al., 2003). Resiliency training, stress inoculation training, or mindfulness training are other types of tools used for prevention of stress-related symptoms and sustain wellness in the police force. The U.S. military routinely includes such training in their operations. This training seeks to stimulate adaption to situational stress after the first few experiences which are typically simulated. The goal is to create self-awareness and the ability to withstand and grow when exposed to stressors and changing demands. Structure and content of such trainings vary widely and evaluation of programs is lacking although some smaller studies suggest positive outcomes (Weltman et al., 2014; McCraty & Atkinson, 2012; Arnetz et al., 2009).

Recommendations from researchers and policy analysts who have looked at traumatic injuries in veterans and others treated in emergency rooms have focused on development of screening instruments to identify risk for poor psychological adjustment following injury. Due to confidentiality concerns, such a tool may have limited use in a work setting, especially by

department personnel who assess fitness for duty after serious incidents occur on the job. These tools are generally recommended for use in a health care setting, where a provider can best determine the need for ongoing treatment and follow-up for those at greater risk of persistent posttraumatic and other mental health problems.

Ongoing monitoring for new episodes, counseling, medical treatment, and rehabilitative care is needed as well as the availability of confidential treatment resources, to preserve privacy. The threat of being found unfit for duty for any psychological illness is a concern for many officers if receipt of mental health services becomes part of their employee record. Having an anonymous hotline number or facilitating contact with these services outside the organization has been found to alleviate this concern (Amaranto et al., 2007). Implementing such programs entails a shift in police culture to one where officers would be encouraged to seek psychological services when necessary and to one where providing opportunities to increase their capacity to process traumatic events, develop resiliency, and ultimately become more effective officers is seen as a positive goal.

As agencies implement new training programs, standard operating procedures, and policy in an effort to reduce on-duty injuries, these changes need to be evaluated and evidence based. However, empirical evidence for effective health and wellness programs in police populations is scarce with better evaluation and documentation of such programs and surveillance is needed (Plat et al., 2011).

Incorporating more occupational health professionals to assist with training and care of law enforcement personnel would help identify the extent of work related hazards leading to injury and might lead to the development of programs and services to help employers identify psychosocial outcomes, substance use, and fatigue. Many of these effects are reversible and early

recognition by occupational health clinicians can alert local public health officials and other government groups to the need for further control measures. Occupational health providers can determine where workers are on the health-illness continuum, identify injury prevention strategies and assess stress-related problems, including shift schedules and use of overtime. Occupational health professionals have not been an integral part of prevention strategies and treatment in the law enforcement community. Reporting their observations in the occupational and environmental literature could prompt more epidemiologic studies and policy changes and broader recognition. They have a broad understanding of stress-prevention programs and how services need to include a combination of organizational change (workplace approaches) and individual stress management (worker approaches) to prevent or ameliorate adverse health outcomes to create a healthier workplace. They can also assist with evaluation of program effectiveness and impact.

As part of the National Institutes for Occupational Safety and Health (NIOSH) Traumatic Injury Research and Prevention Program, occupational safety professionals and agencies have created strategic goals that seek to prevent and expand future research on traumatic nonfatal occupational injury to reduce the direct and indirect costs to U.S. workers. Several emphasis areas have been identified to reduce injuries among high risk and vulnerable worker populations; older workers, racial and minority workers, and groups with injury rates that exceed the average for all workers, including public safety workers. They also recommend collaboration across intramural and extramural agencies and worksites to decrease injury in occupational groups as well as the use of surveillance research findings on high-risk worker groups across public and private sectors (NIOSH, 2014). Occupational injury deaths for U.S. law enforcement personnel are well captured through several national surveillance systems, but collections of data regarding

nonfatal occupational injuries and illnesses is somewhat limited but also a critical component of the field of occupational safety and health. The systematic collection, tabulation, and interpretation of occupational injury and illness data are essential for setting priorities that contribute to achieving a safe and healthy workplace.

Additional stakeholders are the law enforcement agencies and associations that seek to protect officer safety and wellness. IACP is the world's largest association of law enforcement executives. As part of a multi-agency assessment to determine the scope and frequency of injuries sustained by law enforcement personnel, they determined the majority of the injuries would not be found by traditional collection mechanism such as the Federal Bureau of Investigation's Law Enforcement Officers Killed and Assaulted Program or the Uniform Crime Report. They emphasized the importance of detailed recording and tracking of line-of-duty injuries in order to understand the true cost and scope of law enforcement injuries. By better understanding the connections between injuries and factors such as fitness, training, and officer experience; they assert agencies can proactively take steps to reduce future injuries and mitigate injury severity. While there has been minimal research to address law enforcement risks and injuries, the IACP is focused on providing actionable findings that law enforcement organizations can use to inform prevention. By tracking injuries across agencies, trends can be identified and analyzed for use in future training or policy enforcement (IACP, 2012). A near miss reporting system is currently in development by the Police Foundation in collaboration with U.S. Department of Justice Office of Community Oriented Policing Services (COPS Office), and International Association of Fire Chiefs (IAFC) that would help capture minor mistakes that could lead to more serious events. The systems have been in existence for years in aviation, fire services and medicine. Similar systems in aviation, for example, have led to enhanced injury

prevention efforts, and promoted safety enhancements through training, improved systems, and better design.

Future Research

Future research efforts should focus on expanding analyses in the existing BCOPS study to include follow-up exams, detailed injury questionnaire, and work history data with data collection finishing this year. As part of this second exam, preliminary data findings on injury information indicate that most common types of injuries are sprains/strains, cuts /lacerations, and bruises/contusions. Common causes of injury that were reported were traffic incidents and assaults. These types and causes of injuries are consistent with national surveillance and other studies characterizing nonfatal injury in police officers (IACP, 2012; BLS, 2011). In addition, the place and events where the injury occurred is important to consider; officer injuries are common during training, and some occur during off time or personal leave. Longitudinal analysis to establish temporal ordering can occur in the follow up period with the BCOPS study. Given the concern about reverse causation, it will be important for further analyses to control for baseline mental health status and to accurately document the timing of injury events as they occur to also understand the factors that contributed to the injury and to understand what effects occur after.

It is also important to examine stress, mental health and behavior factors as risk factors for injury by type of injury such as on-duty motor vehicle crashes and assaults. Some of this information can be obtained from ongoing cohort studies such as BCOPS, workers' compensation reports, motor vehicle crash reports, and on-site investigative reports. This

quantitative data can be pivotal in furthering our understanding of on-duty injuries and in the development of comprehensive evidence-based prevention programs. The use of qualitative research methods may also be beneficial in gaining greater insight into both officers' and leaderships' perceptions and experiences related to injury, allowing for a more clear picture of how and why these events occur, and how best to reduce the number and severity of these events.

Gender and age differences should be examined more closely. There appeared to be differences in the mental health and behavioral outcomes for those injured for female compared to male officers as well as younger vs. older officers, but sample size limitations may have prevented detecting significant differences. If interaction effects are found, interventions, restrictions, or other steps need to be implemented that target such groups to ensure they continue to work safely. Another area to examine further is the impact of reassignment to light duty and injury occurring outside the workplace, and protective factors and their role in ongoing disability from injury.

The mental health impact of injuries in occupational and other groups should be examined in other police, responder and other occupational groups. This will help with comparing existing research findings and increase power to conduct sub-analyses. Some of the existing national datasets do not contain both injury and psychological symptom information. One potential dataset that is being explored is the National Health Interview Survey; the occupational health supplement contains both occupational injury and illness information limited to public safety occupations in an effort to generalize findings to a larger public safety workforce. Other datasets that potentially could be used to ask similar research questions in responders and military is workers compensation data, veteran's administration data, and World

Trade Center Health Registry data. Comparing findings across groups that are similar in as many respects as possible with the exception of the variable of interest will decrease the likelihood of selection bias created by the healthy worker effect, where those who are selected and remain in police and other responder groups tend to be healthier than unemployed or in other professions that do not require fitness for duty entrance examinations.

Conclusion

This research advances our understanding of the mental health impact of experiencing injury in the line of duty for police and other first responders. These incidents may have an impact on individual police officers in different ways, with some returning to normal functioning in the immediate aftermath, whereas others may require more intensive mental health intervention.

This study supports the need for timely interventions to prevent symptom development in this workforce. These and future studies can assist with identifying first responders at higher risk for psychopathology after injury and direct limited resources for training and early intervention.

Appropriate prevention, intervention, and treatment of stress and other health outcomes associated with police work are essential to preventing psychosocial impairments that contribute to long term disability.

APPENDICES

Appendix A. Quartiles of injury leave (for longest continuous leave period) and associations with CES-D, PTSD, and Anxiety Scores (crude and adjusted)

The length of injury leave variable was not normally distributed-right skewed, with 10 observations with number of days on leave greater than 500. To lessen the influence of these high data points, length of injury leave was categorized. As seen PTSD and anxiety symptom scores were associated with the highest category of leave compared to lower categories of injury leave after adjustment, Table 5.1.

Table 5.1 Linear Regression Coefficients of stress, CES-D, PTSD, and Anxiety Symptom Scores (Crude and Adjusted) by categories of injury leave. BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

Injury Leave ¹	Perceived Stress score n=422		CES-D score n=427		PTSD score n=380		Anxiety score n=416	
	Crude	Adjusted ⁴	Crude	Adjusted ⁴	Crude	Adjusted ⁴	Crude	Adjusted ⁴
	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
17 or more days of leave ²	0.686 (-1.2,3.3)	0.568 (-1.7,2.9)	-1.11 (-3.1,0.86)	-0.99 (-3.0,1.1)	-0.32 (-3.0,2.3)	0.11 (-2.6,2.9)	0.46 (-1.6,2.5)	0.21 (-1.9,2.3)
18-61 days of leave ²	-0.143 (-2.4,2.1)	-0.267 (-2.6,2.0)	-0.33 (-2.3,1.6)	-0.25 (-2.3,0.1.8)	1.40 (-1.3, 4.1)	1.80 (-1.0,4.9)	0.48 (-1.6,2.5)	0.33 (-1.7,2.4)
62-159 days of leave ²	1.11 (-1.2,3.4)	1.32 (-1.0,3.4)	1.28 (-0.70,3.3)	1.45 (-0.59,3.5)	2.54 (-0.08,5.2)	2.83* (0.14,5.5)	1.58 (-0.44,3.6)	1.74 (-0.31,3.8)
160 or more days of leave ²	1.10 (-1.2,3.3)	1.06 (-1.2,3.3)	1.39 (-0.58,3.4)	1.62 (-0.42,3.7)	3.06* (0.41,5.7)	3.62** (0.9,5.7)	3.30** (1.3,5.4)	3.11** (1.0,5.2)

¹Reference-no injury

²Significance: *P<0.05, **P<0.01, ***P<0.001

³P-value: Linear regression-Trend test

⁴Adjusted for age, sex, rank, and traumatic experiences before police work

Appendix B. Resilience, coping and social support by psychological distress symptoms: stress, CES-D, PTSD, and anxiety in injured participants

High mean levels of resilience, proactive coping, and social support were associated with lower perceived stress, PTSD, depression, and anxiety scores in injured participants, Table 5.2. The results suggest the need to preserve and reinforce resilience training, resources prior to and in the aftermath of injury. Those with injury could then be evaluated for stress-related outcomes and appropriate follow up and those without supportive networks at home and work may need extra services. These measures were not found to modify the association between injury and psychological and behavioral factors as hypothesized in the data.

Table 5.2 Mean levels of resilience, proactive coping, and social support by psychological distress symptoms: stress, CES-D, PTSD, and Anxiety in injured participants. Buffalo Cardio-metabolic Occupational Police Stress Study, 2004-2009, Injury data from day-to-day records, 1994-2009; N=430

Protective factor	Total	Low Perceived Stress	High Perceived Stress	No Depressive symptoms	High Depressive Symptoms	No PTSD	Partial or Full PTSD	No Anxiety Symptoms	High Anxiety Symptoms
	Mean± SD	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE	Mean± SE
Hardiness Score n=262	28.1 ±4.9	29.4 ±0.42***	26.7 ±0.42	28.6 ±0.32***	24.7 ±0.32	28.7 ±0.34***	25.3 ±0.73	28.5 ±0.32***	24.9 ±0.83
Proactive Coping n=250	3.98 ±1.0	4.2 ±0.09***	3.8 ±0.09	4.1 ±0.07***	3.5 ±0.17	4.0 ±0.07***	3.8 ±0.15	4.0 ±0.07***	3.7 ±0.17
Social Support n=257	83.1 ±9.1	85.6 ±0.78***	80.5 ±0.79	84.0 ±0.60***	77.6 ±1.5	83.8 ±0.64***	79.3 ±1.4	83.7 ±0.61***	78.4 ±1.5

***p<0.0001

Appendix C. Quantile Regression CES-D by injury type

Injury variables were modeled using of the 0.5 and 0.75 percentile of the CES-D, due to the lack of normality in the outcome data to determine if injury is associated at the higher depression, PTSD, anxiety scores. A squared term was introduced to the model which improved model fit. It also generated more robust estimates given the non-normality of the dependent variables and minimizes the influence of data outliers. There were no differences in mean CES-D scores found with any of the injury variables (Table 5.3).

Table 5.3 Quantile Regression Coefficients-CES-D by injury type. BCOPS Study, 2004-2009, Injury data from day-to-day records, 1994-2009

	Quantile	Coefficients-unadjusted	p-value	Coefficients-Adjusted	p-value
Number of injuries	0.5	0	1.0	0.0455	0.8594
Number of injuries	0.75	0.500	0.1989	0.2662	0.4096
Duration of injury (addition of a squared term)	0.5	0.0099	0.1174	0.0075	0.1694
Duration of injury (addition of a squared term)	0.75	0.0081	0.5823	0.0007	0.9617
Recency of injuries	0.5	-0.3424	0.0549	-0.1264	0.5122
Recency of injuries	0.75	-0.1328	0.6585	0.0990	0.6457

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