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Analysis of Injuries and Costs of Public Safety Occupations: a Systematic Review

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May, 2019

To the Dean of the Graduate School:

We are submitting a thesis written by Jade Witmer entitled Analysis of Injuries and Costs of Public Safety Occupations: A Systematic Review.

We recommend acceptance in partial fulfillment of the requirements for the degree of Master of Science in Sport and Fitness Administration.

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ANALYSIS OF INJURIES AND COSTS OF PUBLIC SAFETY
OCCUPATIONS: A SYSTEMATIC REVIEW

A Thesis presented to the faculty
Of the Richard W. Riley College of Education
In partial fulfillment
Of the requirements for the degree
Of Master of Science
In Sport and Fitness Administration

May 2019

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Abstract

Public safety occupations, such as firefighters and law enforcement, perform physically demanding tasks in unpredictable environments with additional external loads putting them at risk for sustaining a musculoskeletal injury while on duty. The goal of this systematic review was to address the incidence of musculoskeletal injuries and costs related to those in the public safety occupations of firefighting and law enforcement. A systematic search of four databases using key search terms was conducted to identify potentially relevant studies. Using predetermined inclusion and exclusion criteria, a total of 11 studies were extracted and evaluated. Amongst both law enforcement officers and firefighters, the most common musculoskeletal injury sustained was sprains or strains at 17%-47% and 38%-73% respectively. The average cost per insurance claim for firefighters was between \$5,100-\$5,300 and the mean workers' compensation cost for each injury sustained by a law enforcement officer was \$484. Because of the different organization and classification of variables across studies, caution should be used when extrapolating data from this review.

Keywords: police, law enforcement; firefighter; injury, musculoskeletal injury, costs

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Chapter 1: Introduction

Public safety occupations include firefighters, law enforcement officers, and emergency medical services (EMS) who participate in strenuous physical activity and display tireless mental determination. These individuals perform physically demanding tasks such as running, jumping, carrying, and lifting daily. These physical tasks are common in most occupations; however, those in public safety occupations perform these tasks while wearing several pounds of extra equipment under extreme duress with their life at risk. The additional external load influences task performance, limits range of motion, impairs balance, alters gait patterns, and affects posture in unpredictable environments that can lead to an injury (Bock, Stierli, Hinton & Orr, 2015)..

An average of 88,000 firefighters and 100,000 police officers sustain occupational injuries or illnesses each year due to hazards and physical demands they are exposed to daily (LaTourrette, Loughran, & Seabury, 2008). Musculoskeletal injuries represent 59% and 64% of firefighter and police officer injuries respectively, comprising most of the occupational injuries or illnesses sustained by police officers and firefighters (LaTourrette et al., 2008).

Chapter 2: Literature Review

Musculoskeletal Injuries

Musculoskeletal injuries are injuries occurring to a muscle, tendon, ligament, bone, or joint within the body (Hillman & Perrin, 2012). All these structures can withstand external loads and force (Prentice, 2014). However, when the external load exceeds a certain point, called the yield point, deformation can result in injuries such as strains, sprains, fractures, and dislocations (Prentice, 2014). Strains and sprains are a specific type of musculoskeletal injuries that, according to the research, makes up the majority of the injuries public safety occupations sustain (Brandl & Stroshine, 2012; LaTourrette et al., 2008; Lyons et al., 2017; Seabury & McLaren, 2012). Strains are a stretch, tear, or rip in the muscle or its tendon which can occur from over stretching or from a contraction with too much resistance (Prentice, 2014). There are different severities of strains; but regardless, the time it takes to properly heal a strain is lengthy, especially if the muscle is continuously placed under external stress (Prentice, 2014). For example, a hamstring strain takes an average of six to eight weeks to completely heal (Prentice, 2014). If an individual from a public safety occupation decides to return to work and continues to put the injured muscles under external stress, then the recovery time for the individual is extended (Alvar, Sell, & Deuster, 2017).

A sprain occurs when external forces are applied to a joint in which the joint moves beyond its normal limits and causes damage to the ligament (Prentice, 2014). Like a strain, the severity of a sprain can be classified on a graded scale.

Because of the limited blood supply present in ligaments, sprains can take a long time to heal (Prentice, 2014). The average recovery time from a sprain depends on its severity. A grade 1 sprain may heal in two weeks; however, a grade 3 sprain typically requires surgery (Prentice, 2014). The higher the grade of the sprain, the greater the severity of the damage to the ligament (Prentice, 2014). There are multiple factors that may cause a firefighter or law enforcement officer to sustain a sprain or strain. In addition to the external load worn by law enforcement officers and firefighters, the physical duties they perform can put them at risk.

Law Enforcement Officers

The high injury rate among law enforcement officers (LEOs) can be attributed to multiple factors. The duties of LEOs are composed of 80-90% sedentary activity that shift rapidly into a full-exertion pursuit, ending with an attempt to restrain a noncompliant offender all while wearing weighted gear of an average of 25 pounds. (Bock et al., 2015; Boyce et al., 2008; Lyons et al., 2017). Other dynamic tasks that leads to any injury include lifting, climbing, carrying, dragging, pushing, pulling, and fighting in unfamiliar and unpredictable environments (Bock et al. 2015). These physical tasks are typically performed under high stress situations with little to no warning, which can increase their risk of injury (Alvar, Sell, & Deuster, 2017). However, such tasks are not the only risk of injury to law enforcement officers. The extended periods of sitting, wearing duty belts and vests, and looking at mobile data terminals cause frequent discomfort and pain in the low back and spine (Williams &

Ramsey, 2017).

Firefighters

The physical demands of firefighters are like those of LEOs, but the specific duties are slightly different. Firefighters are required to carry victims and ladders, to scale barriers, to climb stairs, and to crawl through obstacles all while wearing gear that weighs on average 45 pounds (Boyce et al, 2008). Firefighters typically perform these duties while exposed to hazardous situations and variable conditions such as unstable structures, uncontrolled fires, chemical spills, and gas leaks (LaTourrette et al., 2008). Unpredictable, prolonged periods of rest are an injury risk factor for firefighters because they could be called to perform any number of these tasks with minimal physical preparation (Boyce et al.,2008). The lack of preparation prior to responding to an emergency in which firefighters wear heavy equipment can lead to injury. Sprains, strains, muscular pain, fractures, and dislocations account for 60% of injuries sustained by firefighters (LaTourrette et al., 2008). Wounds and bruises comprise 20% of injuries while smoke inhalation and burns contribute to only 10% of injuries (LaTourrette et al., 2008). According to the Bureau of Labor Statistics, because of the physically demanding nature of their duties, it can take firefighters twice as long to return to work compared to an individual working in an industrial or private setting (Seabury & McLaren, 2012). This extended period spent away from work is more money the employer must spend in workers' compensation as well as money lost from a decrease in productivity (Larson, Renier, & Konowalchuk,, 2011).

Costs of Musculoskeletal Injuries

With the large number of individuals in public safety occupations that sustain injuries, the cost of injuries adds up quickly for the employer. The average cost of medical treatment for sprains and strains is \$3,175 per injury before insurance is applied (Misra, 2014). Not only are medical costs for the initial doctors' appointment a factor, but so are follow up appointments, including surgery or physical therapy, workers' compensation for any lost workdays due to the injury, and costs to the employer in lost overall production. Costs per injury sustained by a law enforcement officer can range from \$2,500 - \$12,000 (Lyons, Radbum, Orr, & Pope, 2017) and injuries sustained by a firefighter can range from \$5,000 - \$9,000 (Walton, Conrad, Furner, & Samo, 2003) depending on the location and severity of the injury. In a society where high productivity and efficiency at low costs is ideal for success in organizations, it is important for employers to search for ways in which to maintain a healthy workforce, especially when a job has a high risk of injury due to such physically demanding tasks (Larson et al., 2011).

The frequency of the occurrence of musculoskeletal injuries has an impact on costs associated with these injuries. Treating and rehabilitating the injuries properly allows for a decreased recovery time, which enables individuals in public safety occupations to return to work in a timely manner (Lyons et al., 2017). By treating and rehabilitating injuries properly, an employer can save money by decreasing the amount of worker's compensation owed to the

employee, decreasing lost overall productivity and decreasing rate of re-injury (Zimmerman, 1993). There is limited literature that analyzes the number of musculoskeletal injuries sustained by law enforcement officers or firefighters in addition to the costs related to those injuries. The purpose of this review is aimed to bridge the gap in the literature by addressing the incidence of musculoskeletal injuries cost related to those musculoskeletal injuries in the public safety occupations of firefighting and law enforcement. Based on this review, possible injury prevention programs will be proposed.

Chapter 3: Methods

Search Strategy

A literature search was conducted in the spring of 2019 using a southeastern university's online databases including PubMed, Cochrane Database of Systematic Reviews, EBSCOhost, and WorldCat. The following search terms were developed and used in each database for the online search: *(law enforcement OR police) AND (injury)*; *(law enforcement OR police) AND (musculoskeletal injury)*; *(law enforcement OR police) AND (workers' compensation)*; *(law enforcement OR police) AND (insurance claims)*; *(law enforcement OR police) AND (costs)*; *(firefighter) AND (injury)*; *(firefighter) AND (musculoskeletal injury)*; *(firefighter) AND (workers' compensation)*; *(firefighter) AND (insurance claims)*; *(firefighter) AND (costs)*. An additional manual search was performed of references of selected articles that met the inclusion criteria that may not have been included in the search of electronic databases.

Bias. Throughout the study, search bias and duplication bias were limited. Search criteria were kept broad to be more inclusive of studies. Duplicates were removed during the first line of screening to limit duplication bias. Prior to screening articles, the inclusion and exclusion criteria were established to limit inclusion criteria bias. Only one author (J.W.) screened and reviewed the articles. This systematic review had no external funding source.

Inclusion criteria. After performing the electronic database search, the studies were examined for inclusion criteria. Studies were included if they met all of the following criteria: (i) the study population involved firefighters or law enforcement officers in the United States; (ii) one of the variables studied was musculoskeletal injuries

sustained by firefighters or law enforcement officers; (iii) one of the variables studied was the cost of musculoskeletal injuries sustained by firefighters or law enforcement officers (including workers' compensation or insurance claims); (iv) the article was published in 1990 or later; (v) the full article was available; and (vi) the article was written in English.

Musculoskeletal injuries included injuries that were sustained to muscle, tendon, ligament, or bone. General medical illnesses, such as cardiorespiratory conditions, cancer, etc., were excluded from the study. Articles discussing costs related to musculoskeletal injuries included workers' compensation, insurance claims, total medical costs, or a combination of the three. Workers' compensation is classified as the reimbursement of expenses such as lost wages and medical treatment for workers who sustained an injury while on duty (Witt, Bunn, & Slavova, 2018). Insurance claims refers to the amount of money paid by the insurance company to the medical provider regarding medical costs incurred from injuries sustained while on duty (Holloway-Beth, Forst, Freels, Brandt-Rauf, & Friedman, 2016). Total costs include worker's compensation, insurance claims, as well as any out-of-pocket costs paid by the individual that sustained the injury.

Exclusion Criteria. Studies were excluded from the study if they had any of the following criteria: (i) one of the variables did not include musculoskeletal injuries sustained by law enforcement officers or firefighters; (ii) one of the variables did not include costs associated with musculoskeletal injuries sustained by law enforcement officers or firefighters; (iii) study population included firefighters or law enforcement

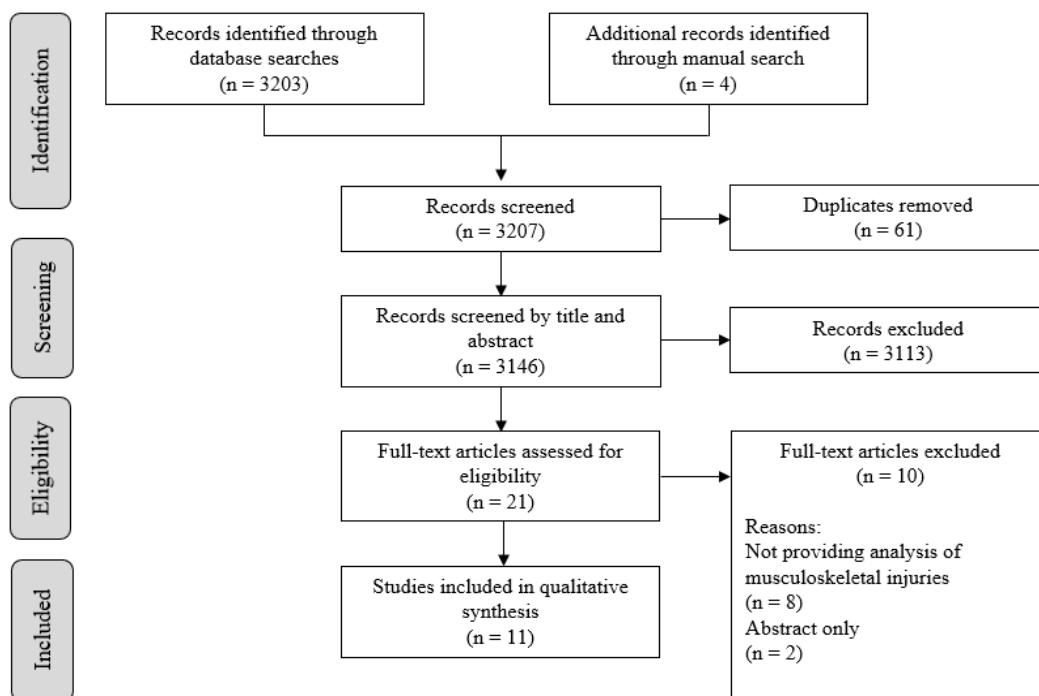
officers outside of the U.S.; (iv) the full article was not available; (v) study was not published in English; (vi) study was published prior to 1990.

Data Collection

After performing the electronic search, EndNote (Clarivate Analytics, 2018) was used to remove duplicates initially before the screening process began. EndNote is a downloadable program that manages bibliographic information and produced by Clarivate Analytics. The title and abstract of the articles identified in the initial search were screened by the researcher using the inclusion criteria to determine if the article could be included for the review and to be analyzed further. Full text articles were examined in detail for inclusion criteria. Articles in which full text could not be obtained were excluded from the study. A manual search of bibliographies was performed on articles that met the inclusion criteria to search for articles that may have been missed during the electronic search. These studies were then examined for inclusion criteria to determine if they could be used for this study.

Data Analysis

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were used to aid this review (See Figure 1). The studies selected to be included in the review were each analyzed by the Oxford Center of Evidence-Based Medicine Level of Evidence to determine the strength of recommendation (See Table 1). Understanding the level of evidence for each article demonstrates the validity of each study. This, in turn, validates the accuracy of the data being presented.

Figure 1. PRISMA flow diagram showing literature search, screening, and eligibility criteria

Chapter 4: Results

A total of 3,203 articles were identified using the electronic search. After thorough screening, 11 articles were extracted and utilized in this review (See Appendix B-d). Various outcomes or findings were present across the extracted studies. Two articles analyzed the musculoskeletal injuries sustained by only firefighters, examining the mechanism of injury and anatomical location of the injury (See Appendix B) (Walton, Conrad, Furner, & Samo, 2003; Jahnke, Poston, Haddock, & Jitnarin, 2013). Two articles incorporated a fitness-based injury prevention program in which they compared one group of firefighters that participated in the program to previous groups of firefighters that had not and identified any trends in overall injury rates and the costs associated with these injuries (See Appendix B) (Griffin et al., 2016; Kuehl et al., 2013). Two articles reviewed the musculoskeletal injuries sustained by firefighters, law enforcement officers, and EMS (See Appendix C) (Reichard & Jackson, 2010; Lentz, Randall, Gross, Senthilselvan, & Voaklander, 2019). Four of the articles used in the systematic review examined musculoskeletal injuries sustained by law enforcement officers and the costs associated with these injuries (See Appendix D) (Boyce et al., 2008; Holloway-Beth et al., 2016; Lyons et al., 2017; Witt et al., 2018). The last article included analyzed the trends of injuries to law enforcement officers and the mechanisms of these injuries (See Appendix D) (Brandl & Stroshine, 2012). The type of injury and mechanism of injury were analyzed based on percent of the population in each study to allow for comparisons across studies.

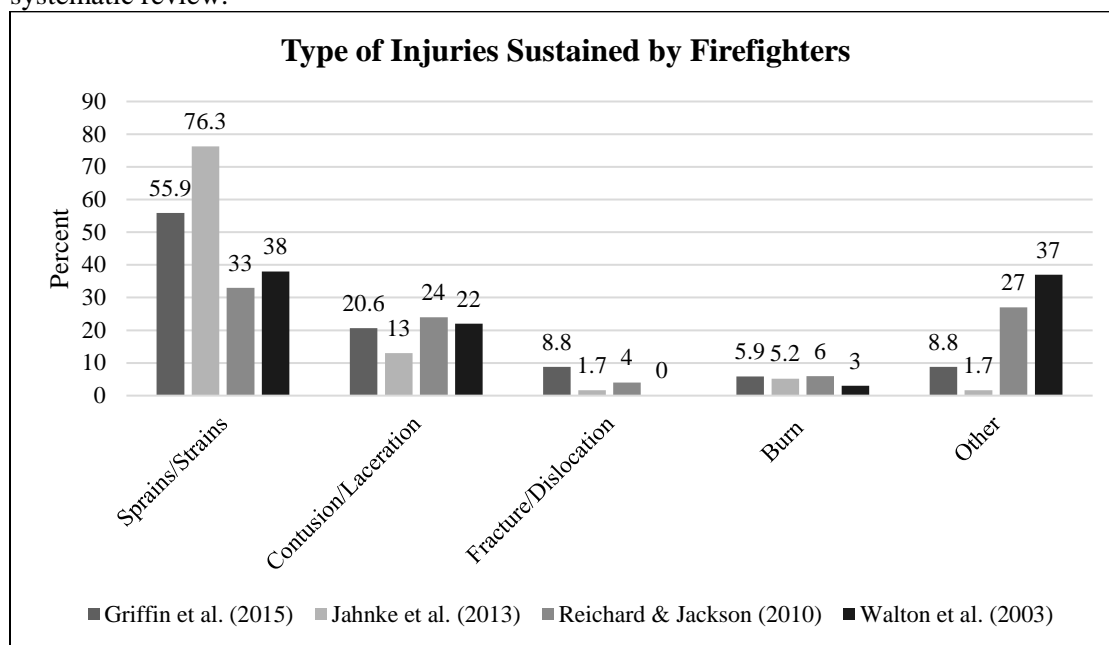
Musculoskeletal Injuries and Associated Costs in Firefighters

In both studies that examined the anatomical location and mechanism of musculoskeletal injury sustained by firefighters, Walton et al. (2003) and Jahnke et al. (2013) found that the most common types of musculoskeletal injury within this population were strains and sprains at 76.3% and 38% respectively (See Figure 2). Instead of identifying basic mechanisms of injury, such as falling, lifting or overexertion, Jahnke et al. (2013) classified mechanisms of injury based on duties performed by firefighters either at the fireground, a non-fire emergency, or training. Because of this, the data from this study is not included in Figure 3. Maneuvering the fire hose accounted for 50% of injuries to firefighters when at the fireground while lifting individuals was responsible for 78% of injuries to firefighters during non-fire emergencies (Jahnke et al. 2013). Walton et al. (2003) used basic definitions for the classification of injury mechanisms, such as overexertion or cuts/punctures.

Walton et al. (2003) found that overexertion was responsible for 33% of musculoskeletal injuries to firefighters (see Figure 3). Griffin et al. (2015) also noted that overexertion was responsible for most musculoskeletal injuries to firefighters. However, Griffin et al. found overexertion to be the primary mechanism for 71% of musculoskeletal injury (see Figure 3) (2015). Walton et al. (2003) listed twelve possible mechanisms of injury whereas Griffin et al. (2015) only listed five possible mechanisms of injury. Griffin et al. (2015) studied firefighters during their recruit academy as well as their probationary year, which is the first 12-14 months on duty after successfully completing the recruit academy. The totals for the control group during their probationary

year were utilized to simulate the standard workload of a firefighter (Griffin et al., 2015). This study also found that strains/sprains compose 72.7% of musculoskeletal injuries in firefighters (see Figure 3) (Griffin et al., 2015).

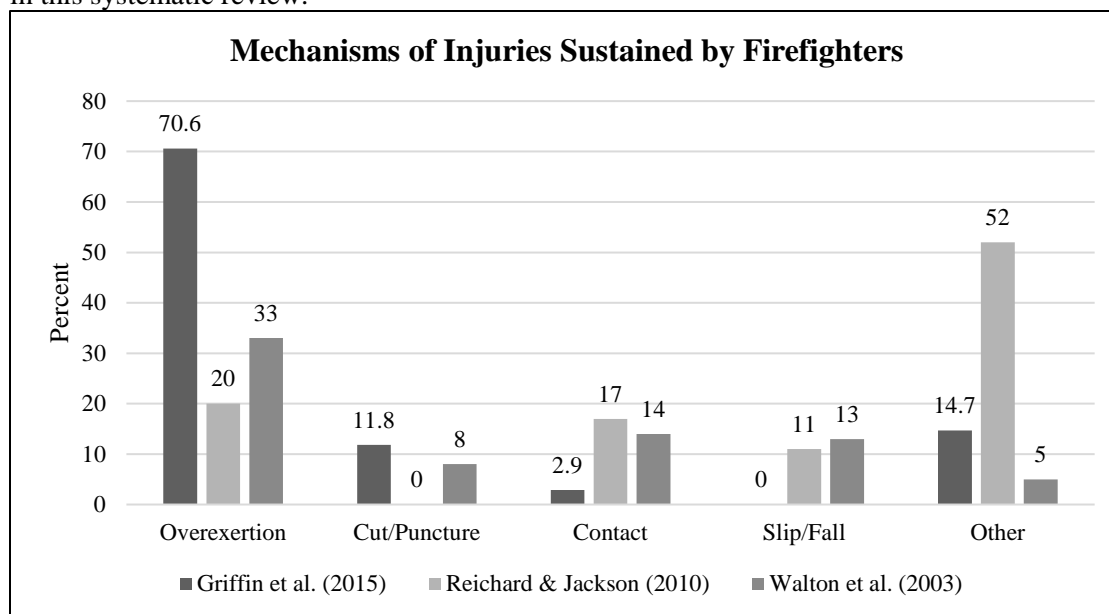
Figure 2. Percent of types of injuries sustained by firefighters from four studies included in this systematic review.



“Other” includes: concussion, unspecified musculoskeletal pain, exposure to blood, bodily fluids or hazardous chemicals, eye, electrical injury, or missing.

Reichard & Jackson (2010) also indicated that strains/sprains were the most commonly diagnosed musculoskeletal injury at 33% of all injuries with 47% of strains/sprains occurring due to overexertion. Contusions and lacerations were the second most common musculoskeletal injury in the articles by Walton et al. (2003), Jahnke et al. (2013), Griffin et al. (2015), and Reichard & Jackson (2010) with 22%, 13%, 20.6%, and 24% respectively (See Figure 3).

Figure 3. Percent of mechanisms of injuries sustained by firefighters from four studies included in this systematic review.



Other includes thermal, transportation-related, assaults, inhalation/ingestion, stress/exhaustion, unspecified, or missing.

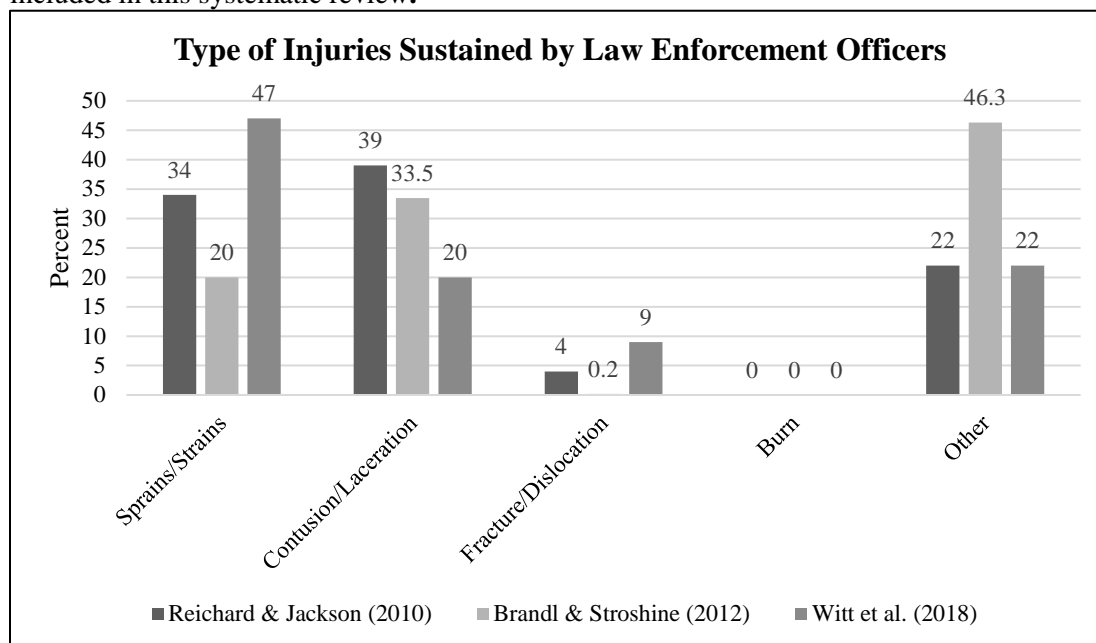
With an average of 333,000 firefighters sustaining a musculoskeletal injury annually, the financial costs for the departments can accumulate quickly (Kuehl et al., 2013). One article found that the average medical cost per firefighter between 2000-2004 was \$5,358 with 194 total workers' compensation claims out of 594 firefighters during the same period (Kuehl et al., 2013). Kuehl et al. (2013) shows a claim rate of 32% which is higher than the claim rate noted by Walton et al., who found only a 10% claim rate amongst 13,343 firefighters with only 1,343 workers' compensation claims filed (2003). According to Walton et al. (2003), the overall mean workers' compensation claim per firefighter is \$5,168 which is like Kuehl et al. (2013). However, the overall mean

workers' compensation claim per firefighter is \$5,168 which is very similar to the findings of Kuehl et al. (2013) (Walton et al., 2003).

Musculoskeletal Injuries and Associated Costs in Law Enforcement Officers

According to Reichard & Jackson (2009), strains and sprains comprised 34% of injuries (see Figure 3). The most common mechanism of injury in this study was found to be exertion at 19% (see Figure 4). Reichard and Jackson (2009) were the only researchers that studied law enforcement officers to find the most commonly injured body part was the lower extremity (19%) (Lyons et al., 2017; Witt et al., 2018; Brandl & Stroshine, 2017). The other articles found that the upper extremity was the most commonly injured location. Only one article solely analyzed the anatomical location and mechanism of injury for law enforcement officers. Brandl and Stroshine (2012) compared location, type and mechanism of injury over different periods of time. They found that strains or sprains compose 17.1% and 22.7% of injuries of law enforcement between 1996-1998 and 2006-2008 respectively (Brandl & Stroshine, 2012). Lyons et al. (2017) performed a critical review of literature regarding musculoskeletal injuries sustained by police, but the articles included also looked at other information such as number of days missed due to injury, potential risk factors for injury and costs associated with musculoskeletal injury. In the articles reviewed by Lyons et al. (2017) they agreed that the most common musculoskeletal injury was a strain or sprain, but the ranges varied from 42.36% to 94.59%.

Figure 4. Percent of types of injuries sustained by law enforcement officers from three studies included in this systematic review.

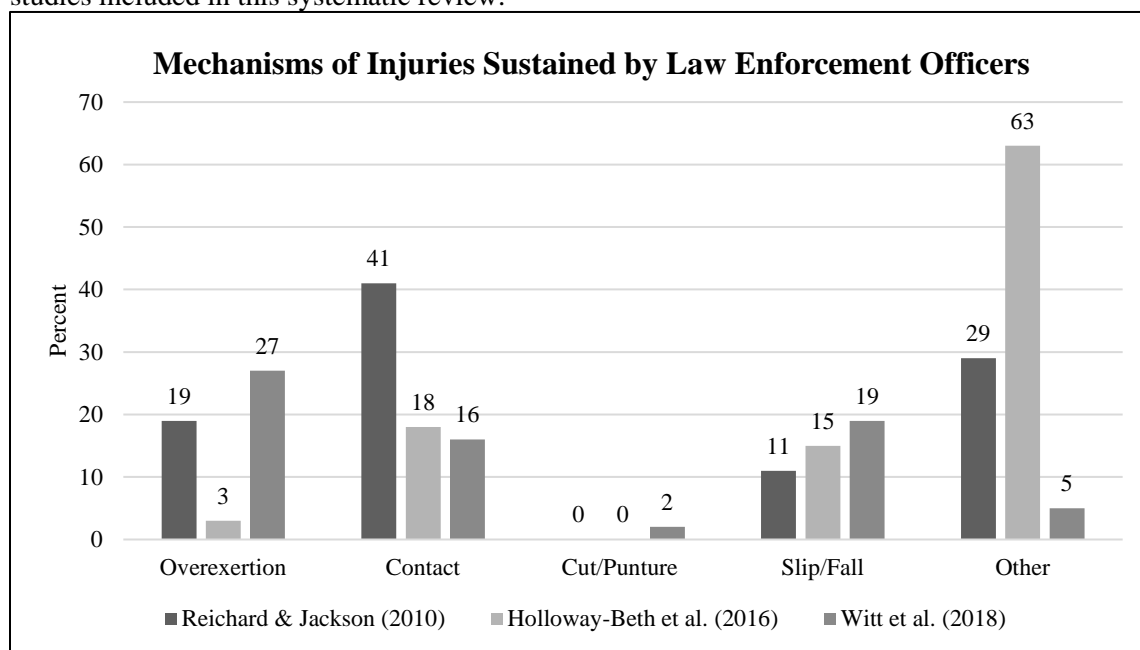


Other includes concussion, inhalation, gunshot wound, knife wound, unspecified musculoskeletal pain, exposure to blood, bodily fluids or hazardous chemicals.

There were three articles included in this review that examined the costs associated with musculoskeletal injuries sustained by law enforcement officers in addition to the type and mechanism of injury. Witt et al. (2018) found that 47% of injuries sustained by law enforcement officers in the public sector were strains or sprains (see Figure 4). Many municipal police officers operate in the public sector compared to the private sector which is why it was used for analysis in this review (Witt et al., 2018). Witt et al. (2018) noted that there were approximately 400 workers' compensation claims amongst law enforcement officers in Kentucky between 2005-2015. Holloway-Beth et al. (2016) only found an average of 273 workers' compensation claims within law enforcement officers between 1980-2008. Boyce et al. (1992) examined the different ranks, sexes, and fitness levels of law enforcement officers and compared them to the

number of workers' compensation claims that were filed. They found that women and individuals who had a Level 4 fitness out of 5 levels, with Level 5 being the most fit, filed for worker's compensation more frequently with a mean workers' compensation total of \$484 per individual (Boyce et al. 1992).

Figure 5. Percent of mechanism of injuries sustained by law enforcement officers from three studies included in this systematic review.



Other includes thermal, transportation-related, assaults, bite, gunshot, unspecified, or missing.

Chapter 5: Discussion

Because of the unpredictable and physical nature of the duties of law enforcement officers and firefighters, this population is at high risk for sustaining a musculoskeletal injury. The costs of these injuries quickly add up for the employer due to workers' compensation costs, insurance claims, and total medical costs. However, there is limited research on possible solutions to reduce or prevent musculoskeletal injuries within public safety occupations. One potential solution could be to implement injury prevention programs. The military has recently begun to implement such programs which could be applied to public safety occupations and lead to a decrease in musculoskeletal injuries and save their departments overall costs related to these injuries.

Injury Prevention Intervention Programs

Two potential programs were discussed in this review. Griffin et al. (2015) developed the Probationary Firefighter Fitness (PFF-Fit) program with the Tucson Fire Department. The goal of the PFF-Fit program was to develop a fitness foundation in probationary firefighters to improve overall health and decrease injuries (Griffin et al., 2015). The PFF-Fit program produced a decrease of claim frequency by 30% within the intervention group compared to the control group that did not participate in the PFF-Fit program (Griffin et al., 2015). The program also produced a return-of-investment (ROI) of 2.4%, saving the Tucson Fire Department money in workers' compensation claims

within the intervention group (Griffin et al., 2015). However, this program has very limited research and should continue to be studied for validity.

Another potential injury prevention program utilized in a study included in this review was the Promoting Healthy Lifestyles: Alternative Models' Effect (PHLAME) Program (Kuehl et al., 2013). According to Kuehl et al., the PHLAME Program was developed to encourage healthy eating habits and increase physical fitness amongst firefighters while on duty (2013). When the PHLAME Program was implemented in Kuehl et al. (2013) study, they found an 8% decrease in workers' compensation claims within the intervention group, compared to an increase of 13% in the control group. Kuehl et al. (2013) also noted only a 7% increase in medical costs per firefighter that participated in the PHLAME Program over a 5-year period. However, there was a 24% increase in medical costs per firefighter in the control group during this same 5-year period (Kuehl et al., 2013). Between 2000-2004, fire departments that participated in the PHLAME Program had a ROI of 4.6%, saving the departments that participated in the PHLAME Program money (Kuehl et al., 2013). Like the PFF-Fit Program, the PHLAME Program has very limited research and should continue to be studied for validity.

Sports Medicine Model

Examining solutions utilized in other populations that experience the same musculoskeletal injuries in addition to being exposed to the similar environment of those in public safety occupations could provide a possible

intervention program. In the military, musculoskeletal injuries are also very common, and soldiers are exposed to physical and hostile environments (Nye & Motte, 2016). One of the interventions that has recently been implemented within the military is the Sports Medicine Model (Cameron, Driban, & Svoboda, 2016). The Sports Medicine Model is a system in which multiple professionals collaborate and work together for the best outcome regarding their patient (see Figure 6) (Cameron, Driban & Svoboda, 2016). An example would be an athletic trainer, physical therapist, sports medicine physician, psychologist and coach working together to ensure the overall health of a basketball player after suffering an injury. Sports medicine teams have provided an exemplary model for appropriate injury prevention, examination, treatment and rehabilitation (Nye & Motte, 2016).

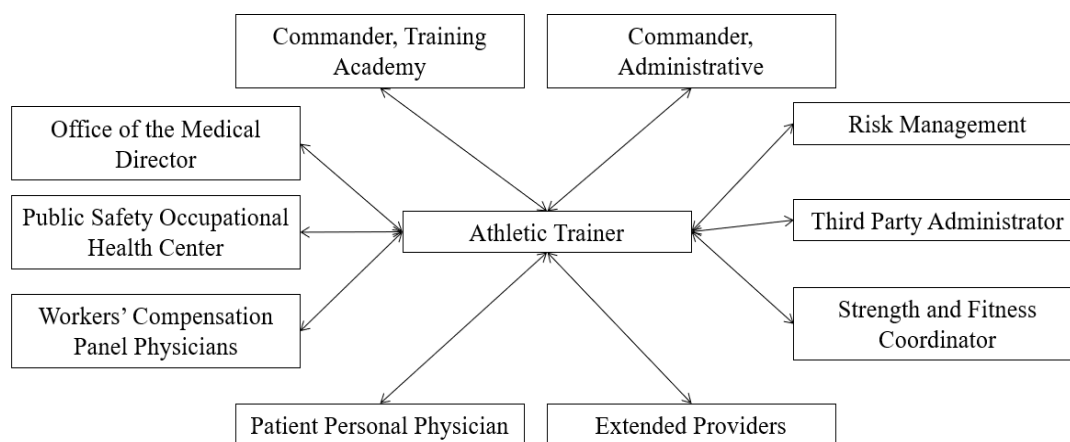
Military Sports Medicine Model. The military refers to their soldiers as “tactical athletes” (Alvar, Sell, & Deuster, 2017). Physical training accounts for up to 90% of musculoskeletal injuries sustained by military personnel, which totaled to \$548 million dollars in costs (Teyhan et al., 2014). A form of the Sports Medicine Model that the military has embraced to reduce its overall cost and injuries is the Sports Medicine and Reconditioning Team Clinic, or SMART clinic (Alvar, Sell, & Deuster, 2017). The SMART clinic model is used by the U.S Navy that also became a part of the U.S Marines with the goal of injury treatment and reduction in orthopedic surgeon referrals (Alvar, Sell, & Deuster, 2017). This model uses sports medicine physicians, athletic trainers, physical therapists, and Master Fitness Trainers

at the initial point of injury to determine if a referral is necessary, to provide appropriate treatment, and to prescribe rehabilitation exercises (Alvar, Sell, & Deuster, 2017; Brawley, Fairbanks, Nguyn, Blivin, & Frantz, 2012). The SMART clinic model was implemented in Camp Lejeune and Camp Geiger in 2007. The SMART clinic model resulted in a 21-43% reduction in referrals to orthopedic surgeons between 2007-2010 (Brawley et al., 2012). The reduction in orthopedic surgical consults shows that early intervention through the sports medicine model decreased the number of individuals that may have needed surgery (Brawley et al., 2012). The decrease in surgical consultations is important because it demonstrates the potential for a decrease in overall medical costs from seeing a physician to undergoing surgery (Brawley et al., 2012).

The Sports Medicine Model has begun to appear within the public safety occupations. Currently, there are only a few fire and police departments that utilize the Sports Medicine Model. The Fairfax County Police Academy in Virginia also hired a full-time athletic trainer in 2005. Since the start of the program, the Fairfax County Police Academy has seen a decrease in overall medical costs by 49.5% and specifically musculoskeletal injury costs by 86.3% (Burke, 2015). The San Antonio Fire Department in Texas hired a full-time athletic trainer in 2015 to aid in injury prevention, treatment, and rehabilitation (Kilpatrick, 2016). Within the first nine months of utilizing an athletic trainer, the San Antonio Fire Department saw a total of \$593,682 in savings from reduced injuries, workers' compensation, and insurance claims

(Kilpatrick, 2016). Data regarding the success of the Sports Medicine Model is limited and should continue to be researched.

Figure 6. An example of the Sports Medicine Model utilized by Fairfax County Police Department. *Burke (2015).*



Athletic Trainers and Physical Therapists

Two key components to the Sports Medicine Model and other injury prevention programs are athletic trainers and physical therapists. Athletic trainers are nationally certified health care professionals that work under the supervision of physicians while practicing within state licensure, certification, or registration statutes. Certified athletic trainers provide emergency care, evaluate injuries, develop a plan for treatment or referral, and establish a rehabilitation protocol for the injury as well as develop injury prevention plans ("BOC standards of professional practice," n.d.). They develop patient-centered outcome plans and document the efficacy of therapeutic interventions and rehabilitation plans. Athletic trainers are required to receive continuing education

in areas related to the field to maintain knowledge and to understand areas where the profession is growing and changing. Athletic trainers must acquire a bachelor's degree from an accredited program to practice athletic training.

A misnomer about athletic trainers is that they only work with an athletic population. Athletic trainers currently work in several environments including physician offices, hospitals, clinics, occupational health environments, industrial settings, and the military ("Profile of Athletic Trainers," 2015). Athletic trainers can analyze the physical demands of a specific population and develop the necessary injury prevention and rehabilitation plans. The biomechanics and physical demands of working on a factory assembly line compared to throwing a football differ, but the process of analysis and goals of injury prevention remain the same for an athletic trainer.

Physical therapists are also certified health care professionals whose goal is to decrease pain and to improve mobility in patients. Their duties include patient evaluation, rehabilitation plan development, utilization of treatment techniques, and creation of fitness and wellness-oriented programs ("Role of a Physical Therapists," 2016). After a patient receives surgery or sustains an injury, a physician may refer the patient to a physical therapist. Physical therapists also use rehabilitation exercises as an alternative to surgery for candidates that may not wish to undergo surgery or are physically unable to withstand the surgery ("Role of a Physical Therapists", 2016). Physical therapists must acquire a graduate degree from an accredited program in order to practice physical therapy and must

obtain licensure from the state in which they plan to practice physical therapy (“Role of a Physical Therapists”, 2016).

Physical therapists are employed in several settings. They work for hospitals to provide inpatient rehabilitation as well as outpatient clinics, nursing or extended care facilities, and make house calls based on an individual’s mobility and capability of traveling (“Role of a Physical Therapists,” 2016). Physical therapists also work in fitness centers and sports training facilities, industrial and occupational environments, and military settings (“Role of a Physical Therapists,” 2016). As the professions of physical therapy and athletic training continue to grow, so will the settings and populations the professions work with. Such populations can include working with public safety occupations, including law enforcement officers and firefighters.

The military populations and public safety occupation populations have similar physical risks based off training and everyday tasks. Therefore, solutions that the military population has used to reduce the total number of injuries and cost of injuries could also be beneficial to those in the public safety occupations. Because athletic trainers and physical therapists are able to complete evaluations, provide treatments, and develop rehabilitation programs, they are able to reduce costs of doctors’ visits, surgical consultations, and outsourced rehabilitation. In addition, athletic trainers and physical therapists are qualified to develop and implement injury prevention programs. Utilizing these professionals, in turn, could fiscally save employers

of public safety occupations.

Chapter 6: Conclusion

In conclusion, this review found that current research literature regarding musculoskeletal injuries sustained by law enforcement officers or firefighters and their associated costs are limited. The most common musculoskeletal injury sustained was sprains or strains in both firefighters and law enforcement officers, ranging from 33% - 76.3% and 20% - 47% respectively. Cases that analyzed the mechanism of musculoskeletal injury found that the most common mechanism of injury for firefighters is overexertion. However, for law enforcement officers the most common mechanism of injury was attempting to restrain a non-compliant offender. Using the sports medicine model as a basis for developing an injury intervention program could help decrease overall musculoskeletal injury rates and associated costs within firefighters and law enforcement officers. However, limited literature exists regarding the application of the sports medicine model amongst public safety occupations. Because of the limited literature that is available, caution should be used when extrapolating data due to the varied methods in which the data across the articles was measured.

Limitations

The articles included in this study were reviewed by only one author. This could allow for selection bias. During the electronic search, the databases analyzed were searched through Winthrop University's library. This could limit the number of available studies present to the researcher. There was a wide range of study designs across all articles included in the review. Because of these differences, it is difficult to develop

conclusive findings based upon their results. Another limitation includes how the variables were reported. Differences existed across studies regarding type of injury, mechanism of injury, and location of injury making it difficult to compare results across studies. All articles included in the study had a level of evidence of III or lower, indicating low strength of recommendation of the studies performed.

Further Research

Future research studying injuries sustained by public safety occupations and their associated costs needs to be conducted. Standards should be set for type of injury, location of injury, and mechanism of injury to compare results across studies within this population more easily. Studies should also be conducted evaluating the associated insurance, medical, and workers' compensation costs by location, mechanism, and type of injury to understand the overall costs of musculoskeletal injuries within this population. Further research should also be done regarding injury prevention interventions such as the PHLAME fitness model, the PFF-fit model, and the Sports Medicine Model in order to validate these interventions.

Appendix A

Oxford Center for Evidence Based Medicine Levels of Evidence and explanations

Level	Type of evidence
1a	Systematic review with homogeneity of randomized control trials
1b	Individual randomized control trial with a narrow confidence interval
1c	All or none related outcome
2a	Systematic review with homogeneity of cohort studies
2b	Individual cohort study (including low-quality randomized control trials, e.g., <80% follow-up)
2c	“Outcomes” Research; Ecological studies
3a	Systematic review with homogeneity of case–control studies
3b	Individual case–control study
4	Case-series (and poor-quality cohort and case–control studies)
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or “first principles”
Grades of recommendation	
A	Consistent level 1 studies
B	Consistent level 2 or 3 studies or extrapolations from level 1 studies
C	Level 4 studies or extrapolations from level 2 or 3 studies
D	Level 5 evidence or troublingly inconsistent or inconclusive studies of any level

Appendix B

Authors (Year)	Objective/Aim	Study Population	Participant Details	Study Design	Main Findings	Level of Evidence
Griffin et al. (2015)	The goal of the study was to evaluate the injury outcomes as well as the return of investment of the PFF-Fit program, comparing the cohort in the pilot intervention with historical controls from previous Tucson fire Department firefighter recruit classes.	109 recruits from 2007, 2008, 2009, and 2012	Recruits from the Tucson Fire Department recruit class of 2012 was administered the PFF-Fit intervention and compared against data from the recruit classes of 2007, 2008, and 2009.	Prospective Case Control Study	The majority of injuries for both groups was sprains/strains (65.4%). The most common mechanism of injury was overexertion for the control group (65.7%) and the intervention group (78.6%). The control group incurred a total cost of \$95,582 from injuries whereas the intervention group demonstrated a 30% reduction in claim frequency.	Level IV
Walton et al. (2003)	The aim of the study was to analyze worker's compensation records of firefighter injuries sustained between 1992-1999 from Illinois Fire Department	13,680 firefighters	Firefighters in northeastern Illinois between 1992-1999 was used for the study.	Retrospective cross-sectional secondary analysis	The majority of injuries sustained by firefighters were sprains/strains (38%). The most common mechanism of injury was overexertion (33%). The mean cost of injury was overexertion was \$9,715. The mean cost of sprains/strains was \$8,031.	Level III b
Kuehl et al. (2013)	The aim of the study was to evaluate the impact of a workplace health promotion intervention on workers' compensation claims and medical costs among Oregon fire departments participating in the PHLAME health promotion programme compared with Oregon fire departments not participating in PHLAME	745 firefighters in intervention group 624 firefighters in control group	Firefighters from Salem and Portland, Oregon fire departments participated in the PHLAME program. Firefighters from Eugene and Tualatin Valley, Oregon participated in the control group	Retrospective Cohort Study	There was an 8% decrease in the number of claims within the PHLAME fire departments compared with a 13% increase among the control fire departments. Researchers also found a 7% increase in medical costs per firefighter in the intervention group during the 5 years the PHLAME program was implemented, creating a \$312 increase per firefighter. This is compared to the control group where there was a 24% increase in medical costs, increasing the cost per firefighter to \$106 during the same period.	Level III b
Jahnke et al. (2013)	The goal of this study was to examine the relationship between reported on-duty exercise, as well as non-occupational risk factors, and exercise and musculoskeletal injuries	462 career firefighters	Firefighters from randomly selected fire departments in the Missouri Valley Region completed the injury questions and were included in the final report.	Retrospective Case Control Study	The majority of injuries sustained were dislocations and sprains/strains, composing 76.3% of injuries. The most common fire ground injuries occurred while manipulating a fire hose (50%) and the most common non-fire related emergencies including lifting people (77.8%).	Level IV

Analysis of articles that met the inclusion criteria and discussed firefighters in this review

Appendix C

Authors (Year)	Objective/Aim	Study Population	Participant Details	Study Design	Main Findings	Level of Evidence
Reichard & Jackson (2010)	The aim of this study was to analyze the nonfatal injuries sustained by firefighters, police, and EMS seen in emergency departments between 2000-2001.	21,900 EMS personnel 37,300 firefighters 64,800 law enforcement officers	The author used the National Institute for Occupational Safety and Health database to collect the data regarding work-related injuries that were treated in 24 hour emergency departments across the US.	Retrospective Cohort Study	The majority of injuries sustained by firefighters were sprains/strains (33%) which commonly affected the lower trunk (23%). The primary mechanism of injury for firefighters was caused by bodily motions, referring to overexertion or pushing the body beyond its normal limits (51%). The majority of injuries sustained by police officers were sprains/strains (34%) which commonly affected the lower trunk (19%). The most common mechanism of injury was bodily motions (47%).	Level IV
Lentz et al. (2018)	The goal of this study was to systematically review existing literature to examine the relationship between fitness and work-related musculoskeletal injury amongst emergency responders.		The author found 16 articles that were usable for the review after searching through PubMed, CINAHL, EMBASE, and MEDLINE.	Systematic Review	The authors found 11 articles to include in the review after performing an electronic search of MEDLINE, SportDiscus, CINAHL, EMBASE, and Google Scholar. Throughout their research, the authors identified that firefighter injuries occur from 11.2 to 30.4 injuries per 100 firefighters in 1 year. Police officer injuries occurred in every 22 injuries per 100 officers in 1 year.	Level IV

Analysis of articles that met the inclusion criteria and discussed law enforcement officers and firefighters in this review.

Appendix D

Authors (Year)	Objective/Aim	Study Population	Participant Details	Study Design	Main Findings	Level of Evidence
Brandl & Strohshine (2012)	The purpose of the study is to examine the extent to which the physical hazards of police work have changed in the Milwaukee Police Department between 1996-1998 and 2006-2008.	1,713 law enforcement officers between 1996-1998 1,604 law enforcement officers between 2006-2008	The author used injury reports filed by sworn officers employed by the Milwaukee Police Department in 2008 and compared it to the same population from 1996-1998 and 2006-2008.	Retrospective Cohort Study	The most frequently reported injury was sprain/strain between both 1996-1998 (17.5%) and 2006-2008 (22.7%). The most common mechanism of injury was attempting to control/arrest a subject for both 1996-1998 (42.9%) and (38.5%).	Level IV
Witt et al. (2018)	The goal of this study was to describe injuries among public and private security and law enforcement personnel and identify the odds and differences of awarded benefits between public and private security and law enforcement personnel.	Law enforcement officers and security officers in the private and public sector in Kentucky between 2005-2015	3478 first reports of injuries were identified in security and law enforcement personnel in the public sector in Kentucky between 2005-2015. 899 first reports of injuries were identified in security and law enforcement personnel in the private sector in Kentucky between 2005-2015.	Retrospective Cohort Study	The primary injury sustained by security and law enforcement personnel was sprains/strains in both the private (37%) and public (47%) sectors. The most commonly injured area identified in security and law enforcement personnel was the upper extremities in the private (21%) and public (29%) sectors.	Level IV
Boyce et al. (1992)	The purpose of this study was to identify a relationship between physical fitness and workers' compensation claims amongst police officers.	514 law enforcement officers	The participants were officers of a large metropolitan police department in a major southeastern city.	Retrospective Cohort Study	This study found that those officers that fell into fitness level 1 (the lowest) and fitness level 5 (the highest) had the lowest number of workers' compensation claims compared to levels 2, 3, and 4. Officers with level 4 fitness displayed the highest mean workers' compensation total per individual (\$484). It also noted that a majority of the injuries sustained by officers resulted from pursuing and restraining non-compliant offenders (59%).	Level IV
Lyons et al. (2017)	The aim of this study was to critically appraise resent literature regarding musculoskeletal injuries within the law enforcement.		The author found 16 articles that were usable for the review after searching through	Systematic Review	The most common site of injury recorded by four of the studies was the upper extremity (32.95% to 43.42%). The most common injury recorded by five of the studies was	Level IV

Authors (Year)	Objective/Aim	Study Population	Participant Details	Study Design	Main Findings	Level of Evidence
	profession to develop a profile of the injuries experienced by the population		PubMed, CINAHL, EMBASE, and MEDLINE.		sprains/strains. (42.36% to 94.59%). The most common mechanism of injury was attempting to control/arrest a subject (31.5% - 61.67%).	
Holloway-Beth et al. (2016)	The goal of this study was to review workers' compensation claim data from the Illinois Worker's compensation Commission to determine annual cumulative claim rates for injuries by police, determine common mechanism of injuries, and evaluate long-term impacts related to workers' compensation.	18,892 law enforcement officers	The author analyzed workers' compensation data from 1980-2008 of Illinois law enforcement officers.	Retrospective Cohort Study	The most common site of injury found in municipal officers was the upper extremity (31%). The mean total monetary compensation, including disability and workers' compensation was \$19,363.82.	Level IV

Analysis of articles that met the inclusion criteria and discussed law enforcement officers in this review.

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