IMPLICATIONS OF SLEEP DEPRIVATION FOR THE AMERICAN FIRE SERVICE

Research Presented in Partial Fulfillment

of the Requirements for the

Executive Fire Officer Program

by

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Abstract

A regular, consistent sleep routine including quality, depth, and duration of sleep are essential for human well-being. The nature of shift work, specifically the traditional firefighter 24-hour shifts poses significant health risks for emergency responders that are largely unknown due to lack of evidence specific to this population. This paper aims to highlight the importance of sleep and the lack of resources for firefighters to understand the harmful effects of sleep deprivation.

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Contents

CHAPTER 1: INTRODUCTION

Firefighters face frequent exposure to high risk, high expectation environments, including structural fires, structural collapse, high heat, low visibility, and hazardous materials. These exposures are complicated by the possibility of physical injuries including burns, and other trauma. This makes firefighting the single most stressful non-military occupation in our society (Hard et al., 2018). The rotating shift system worked by most firefighters contributes to irregular sleep patterns, poor sleep quality, and insufficient sleep (Jang et al, 2020; Frost, et al., 2021). The effects of such mentally and physically demanding work are compounded by poor sleep hygiene (Frost, et al., 2021). According to Barger et al. (2015) 37.2% of firefighters in their study reported having one potential sleep disorder.

The International Classification of Sleep Disorders defines insufficient sleep as a curtailed sleep pattern occurring most days and lasting for at least 3 months coupled with daytime sleepiness (Chattu, et al., 2019). Sleep insufficiency has been linked to nearly half of the top 15 leading causes of death in the United States. These include cardiovascular disease, malignant neoplasm, cerebrovascular disease, accidents, diabetes, septicemia, and hypertension (Kochanek, Murphy, Xu, & Arias E, 2013).

Chattu, et al. (2019) cites an increasing number of cardiovascular events tied to sleep deprivation. Additionally, this author cites increases in obesity, diabetes, as other health concerns linked to insufficient sleep. There are also cognitive and psychomotor function disturbances resulting from lack of sleep. These disturbances lead to increases in vehicle and workplace accidents (Chattu, et al., 2019). Common across all age groups, sleep deprivation or sleep insufficiency is considered to be a public health epidemic that is often under-recognized, under-reported, despite having substantially high economic costs (Chattu, et al., 2019).

Background

Sleep is a basic human need, at the biological level. Walker (2017) states that sleep is of vital importance to life, wellness, and longevity yet still largely understood until very recently. This author continues describing the importance of sleep when it comes to the human abilities to learn, memorize, and form logical decisions. Additional benefits include improved mood stability, immune responses, metabolism and appetite.

Bulkeley (2014) chronicles the progression of sleep deprivation in the following way. The first stages begin with feelings of fatigue, irritability, and trouble concentrating. This is followed by cognitive effects including difficulty reading and speaking as well as lapses in judgement. Physiological changes include a lower body temperature and an increased appetite. The final stages of sleep deprivation described by Bulkeley (2014) include disorientation, visual disturbances or hallucinations, apathy, extreme lethargy and withdrawal from social situations.

Significance of the Study

Human factors, including sleep deprivation have been cited as contributing factors to several catastrophes including 3-mile island, Chernobyl, and the Challenger shuttle explosion (Harrison & Horne, 2000; Landrigan et al., 2004). Numerous industries have instituted limitations on work periods while also requiring specified rest period durations. The Occupational Safety and Health Administration (OSHA) (2022) defines a normal work shift as "a work period of no more than eight consecutive hours during the day, five days a week with at least an eight-hour rest" (para 1). The Commission on Accreditation of Medical Transport Systems (CAMTS) declares shifts longer than 24 hours to be unacceptable in most circumstances (2018, p. 1-10). The Federal Aviation Administration (FAA) has instituted shift duration for flight crews based on crew configuration, shift start times, shift durations, and number of flights

per shift (FAA, 2011). The Federal Motor Carrier Safety Administration (FMCSA) (2022) limits passenger carrying drivers to a 10-hour maximum drive time following 8 hours off.

Based on the knowledge that sleep deprivation provides unique challenges for safety-critical domains, the 21st Century Fire and Emergency Services White Paper authored by the Center for Public Safety Excellence(CPSE) (2020) recognizes the impacts of sleep hygiene and advocates for research on work and sleep cycles which have been identified in other occupations as a priority due to the association between health, error, and sleep. The ultimate goal is the improvement of health and wellness of members of the fire service. Additionally, the document states the fire service should "Utilize the results of that research to make any needed operating policy changes, incorporate research results into appropriate standards, and pursue potential legislative changes to protect the health of the workforce" (CPSE, 2020, p. 16).

Problem Statement

The problem is despite numerous calls for action regarding sleep deprivation among firefighters, there is a lack of current educational resources for firefighters highlighting the importance of sleep hygiene. As a result, there is an increasing emphasis placed on research that investigates the importance of understanding the role of sleep on firefighter health and safety.

Purpose Statement

The purpose of this research is to identify currently available educational resources for firefighters on sleep hygiene. Further, this research aims to identify gaps in the currently available research and educational resources. Finally, propose solutions to identified research and educational gaps.

Research Questions

Q1: What educational resources are currently available for firefighters regarding the importance of sleep and the effects of sleep hygiene?

Q2: What current research exists on the firefighter population regarding sleep deprivation? What improvements could be made in terms of educating firefighters on sleep and sleep deprivation?

Summary

Sleep deprivation has been identified as a global epidemic, as implicated in numerous studies on the role of sleep and cognition at large-scale accidents. The safety-critical nature of fire and emergency services response inherently sets up emergency responders for poor sleep hygiene and subsequently the negative effects resulting from sleep deprivation. In Chapter 2, existing literature will be examined to identify the scope of the sleep deprivation problems including negative cognitive, psychomotor, and affective effects.

CHAPTER 2: LITERATURE REVIEW

This chapter integrates previous research on sleep as it relates to human performance including normal and abnormal function both physically and mentally. There are an increasing number of fire service specific research studies to reinforce the research previously conducted in other occupations and populations including medical sciences, transportation, aviation, and the military. This previous literature coupled with more contemporary research specific to the fire service will provide support for this research.

Existing Literature

Sleep is a necessity for overall wellbeing (Barnes & Drake, 2015) including peak physical performance (Pilcher & Huffcutt, 1996) as well as cognitive ability (Aloha & Polo-Kantola, 2007; Kilgore, 2010). Physically oriented occupations such as firefighting face an increased risk of musculoskeletal injury as a result of sleep deprivation (Lang et al., 2012; Macularlane, et al., 2009). Current recommendations stipulate adults require 7 to 9 hours of sleep per night. Despite this recommendation, Hirshkowitz, et al. (2015) and Mollayeva et al. (2016) reports many adults suffer from poor sleep hygiene including difficulties falling and/or staying asleep, breathing disorders such as sleep apnea, daytime sleepiness, and/or the need for medications to alleviate these symptoms.

Firefighters are no exception to these sleep difficulties (Billings and Focht, 2016; McGillis, et al., 2017; Lim, 2014). Firefighters are plagued with obstructive sleep apnea (Medic, Wille, & Hemels, 2017) as well as a delayed response time (Aloha & Polo-Kantola, 2007), hypertension (Medic, Wille, & Hemels, 2017), cardiovascular disease (Hovenarr-Blom, et al., 2011; St-Onge, et al., 2016), obesity (Kaipust, 2019), psychological and mental impairments

including binge drinking, depression, and generally poor mental well-being (Barger,et al., 2015;Carey et al., 2011; Dinges, 1997; How et al., 2016; Vargas de Barros et al., 2013), and other physical difficulties with basic physical function (Pilcher & Huffcutt, 1996).

A publication authored by the International Association of Fire Chiefs (IAFC) in conjunction with the United States Fire Administration (USFA) titled "The Effects of Sleep Deprivation on Firefighters and EMS Responders" (Elliot & Kuehl, 2007) highlighted similar findings in firefighters suffering from sleep deprivation. The IAFC / USFA report details effects of sleep deprivation including reduced vigilance and psychomotor reaction time, fatigue, mood disturbances, and overall physical health and quality of life. This report further cites poor sleep hygiene is caused by the nature of the shift work performed by firefighters. Shifts in excess of 12 hours each and/or totaling more than 40 hours per week, according to Caruso et al. (n.d.), are linked to increased in injuries and a degradation in performance. A further report by Akerstedt & Wright (2009) illustrates how these physical and mental effects are not limited to firefighters but also found in shift workers across many industries. The difference between firefighters and the general workforce is the level of complexity and uncertainty in the operational environment.

A typical shift for a firefighter can place that firefighter under extreme cognitive demands that require intense concentration, access to both short- and long-term memory, and imperative rapid reaction times (Greenlee et al., 2014; Hemmatjo, et al., 2020). Specific to firefighters is the acute loss of memory in high stress situations such as emergency response (Metcalfe, et al., 2019) as well as other psychomotor effects (Jewett, et al., 1999; Balkin, et al., 2004). Firefighters are required to maintain a high level of physical fitness to perform their job functions (Hauschild, et al., 2017; Richmond et al., 2008). In addition to the mental demands experienced by firefighters, they are also faced with significant physical demands including dragging victims

and/or hoselines or hoisting ladders in less than ideal environments (Lemon & Hermiston, 1977; Rossi, 2003). The physical work performed by firefighters is often directly associated with an increased rate of musculoskeletal injury (National Fire Protection Association (NFPA), n.d.). This results in an increase of health costs for firefighters (TriData Corporation, 2004).

When cognitive and physical tasks are performed simultaneously, and increase of physical exertion biomarkers is noted according to Srinivasan et al. (2016). This results in impaired physical ability (Marcora, Staiano, & Manning, 2009). Given the high cognitive and physical demands of firefighters, poor sleep hygiene may have more of a negative impact on firefighters than other occupations (Alhola & Polo-Kantola, 2007; Kilgore, 2010; Montesinos, 2018; Howell, et al., 2018).

Synthesis of Literature

The body of research on the effects of sleep deprivation has increased since the findings of Elliot & Kuehl (2007) were published, strengthening the argument that sleep deprivation is a threat to firefighters (Haddock et al., 2013, Vincent, et al., 2018; Ferguson, Browne, & Rockloff, 2016; Vincent et al., 2016; Vincent et al., 2016; Stout, 2020). A question about generalizability to all firefighters is raised by Vincent et al. (2018),citing a decrease in cognitive function with no associated decrease in physical ability in wildland firefighters. This may be attributed to the differences in wildland firefighting schedules compared to municipal firefighters. An additional complicating factor is that many of the studies on firefighter sleep deprivation (Ferguson et al., 2016; Wolkow et al., 2015; Wolkow et al., 2016; Cvirn et al., 2017; Vincent, et al., 2015) were performed under simulated conditions. Field studies offer the best ability to measure the impact of the harsh conditions firefighters work in. A further complicating factor is that simulating the austere environments experienced by firefighters would be difficult to perform ethically

(Metcalfe et al., 2019). Parker et al. (2017) specifically addressed measuring physiological response in real world operations through the use of non-invasive wearable technology. The challenge still exists that replicating real world experiences is impossible because of the uncontrollable situations firefighters often find themselves in. This necessitates the need for both field, real world studies coupled with simulated controlled laboratory type studies to create a comprehensive understanding of the impacts of sleep deprivation on firefighters. With the increased body of literature available on the topic of sleep deprivation in firefighters, a systemic literature review can offer valuable insight into proposing best practices for preventing the effects of sleep deprivation.

The Physiology of Sleep

Typically, humans experience five cycles of sleep per night. Each cycle consists of both Rapid Eye Movement (REM) and Non-Rapid Eye Movement (NREM) sleep (Carskadon, 1993). REM sleep is described as a completely flaccid state which may or may not be coupled with muscle twitches. NREM sleep differs from REM sleep in that NREM sleep includes only a reduction in muscle tone, a slower rate of breathing, slower or absent eye movements, and reduced neurological activity in the brain (Carskadon, 1993). For the average person, NREM sleep accounts for 75 percent of total sleep while REM accounts for the remainder (Majde & Krueger, 2005).

Further divisions of NREM sleep include three (Luyster et al., 2012) stages In the first stage, the sleeper is easily awakened by sensory stimuli including light, sound, smell, and touch. Stage two is described by an increased difficulty waking the sleeper. The third stage is characterized by an even harder time awakening and associated specific, slow wave brain activity. Stimuli required to awaken the sleeper must be more substantial (Luyster et al., 2012).

When awakened from stage one, the sleeper is likely refreshed and alert, that same person awakened from stage three will experience the effects of sleep inertia (Joffe, 2006).

"The feeling of grogginess, disorientation, drowsiness, and cognitive impairment that immediately follows waking" is the definition of sleep inertia provided by Burke, et al. (2015). Divided into two categories, subjective alertness and cognitive performance, sleep inertia impairs alertness and performance (Jewett et al., 1999). These symptoms can last up to four hours (Tassi & Muzet, 2000). Other research by Jewett et al. (1999) describes subjective alertness returning after 40 minutes and cognitive impairment being restored after 70 minutes. Studies (Achermann et al., 1995; Ficca et al., 2010) found that individual severity varies and neurobehavioral performance impairment can last two or more hours. Of key importance to firefighters, Tassi & Muzet (2000) cite, prior sleep deprivation enhances sleep inertia. Another key piece for firefighters is that alertness and cognitive function decreases over the course of the day (Duchon & Smith, 1993).

Current Best Practices

Several high risk, high consequence endeavors already have best practice standards or regulations in place. The Commission on Accreditation of Medical Transport Services (CAMTS) requires recommends shift durations no longer than 12 hours (CAMTS, p. 1.10, 2018). The following additional requirements for those working shifts longer than 12-hours is quoted from the CAMTS accreditation standards.

a. Medical personnel are not required to routinely perform any duties beyond those associated with the transport service.
b. Medical personnel are provided with access to and permission for uninterrupted rest after daily medical personnel duties are met.

c. The physical base of operations includes an appropriate place for uninterrupted rest.

d. Medical personnel must have the right to call “time out” and be granted a reasonable rest period if the team member (or fellow team member) determines that he or she is unfit or unsafe to continue duty, no matter what the shift length. There must be no adverse personnel action or undue pressure to continue in this circumstance.

e. Management must monitor transport volumes and personnel’s use of a “time out” policy (CAMTS, p. 1.10, 2018).

Additional provisions are made within the CAMTS standards for shift durations longer than 24 hours which include a base averaging less than 1 transport per day, at least 10 hours of uninterrupted rest per 24-hour period, remote locations with commute times greater than 2 hours one-way, and the use of a fatigue management tool (CAMTS, 2018).

The National Accreditation Alliance of Medical Transport Applications (NAAMTA) calls for 16 hours of duty within a 24-hour timeframe for ground medical crews. NAAMTA standards defer to FAA guidelines for flight medical crews. When 24-hour shifts are necessary, NAAMTA calls for the following:

- Personnel are provided uninterrupted rest after daily duties are met such as bag checks, meetings, and/or other administrative assignments.
- The facilities include crew quarters or secluded area for rest.
- Personnel who feel that he or she is unfit (as opposed to fit) or unsafe for work: irrespective to shift length, can request a "reasonable rest period" without duress.
- To determine if rest periods are used wisely, management and the safety committee should evaluate these periods (NAAMTA, 2018, p. 25).

The Federal Aviation Administration has specific regulations for Helicopter Hospital Emergency Medical Evacuation Services (HEMES), 14 C.F.R. 135 § 271 (2023) stipulates that flight crew members cannot exceed 8 hours of flight time in any 24 hour period and must be relieved a duty if 8 hours of continuous rest cannot be achieved in that 24 hour period. This regulation further stipulates that a minimum 10 hour rest period is required immediately prior to the flight crew member's shift.

Summary

A significant body of evidence highlights the importance of sleep. Recent studies have highlighted how the unpredictable nature of emergency services coupled with long shifts can have various physiological effects both acutely and long-term. Similar high risk, high consequence industries, such as aviation, have implemented best practice guidelines for work and rest periods. Based on the available resources, there is a lack of information and educational materials provided to firefighters on the importance of sleep hygiene.

CHAPTER 3: METHODOLOGY

Disciplines like medicine and social science rely on evidence-based guidelines for credible decision making (Sutherland, et al., 2004). The mapping or scoping review has resulted from this demand for a systematic process to search, collect, synthesize, and apprise various sources of evidence to provide consolidated information sources (Clapton, Rutter, & Sharif, 2009; Gough, Oliver, & Thomas, 2012). Although a scoping review may appear similar to a traditional literature review, the process is significantly more rigorous, objective, and transparent helping to prevent selection and publication bias. The scoping review process is more transparent allowing future researchers to see how inclusion and exclusion decisions were made and conclusions were reached (Gough, Oliver, & Thomas, 2012). This EFO capstone focuses on the scoping review due to the belief there is a lack of evidence specific to fire and emergency services with regards to the harmful effects of sleep deprivation. The scoping review illustrates the various sources of information available on the topic as well as exposing gaps in literature for future consideration.

Research Design

This study will examine available literature through a scoping or mapping review. The origins of the scoping or mapping review are found in the systematic review which is regarded as the 'gold standard' for evidence synthesis from multiple sources (Sutherland, et al., 2004). Although the systematic review is regarded as the best approach to reviewing multiple studies to inform a decision, some questions are not suitable for a systematic review because of the amount or type of data that is available (Haddaway, 2015). In the case of this research, the type of literature available includes academic sources such as peer reviewed journal articles as well as nonacademic sources such as trade journal articles and grey literature which includes

government reports and technical bulletins. The spectrum of available literature makes the mapping review the appropriate choice.

Policy makers are often filled with questions that extend beyond the explicit data including “how” or “why” type questions. For example, policy makers may desire to know what barriers exist and how they can be overcome (Gough, Thomas, & Oliver, 2012). These types of ‘open-framed’ questions do not necessarily translate into the closed natured questions necessary for a meta-analysis or systematic review. Sometimes, evidence is being collected in an effort to inform the need for a subsequent study or further research. As an example, data may be gathered for stakeholders to demonstrate what primary data already exists and how it can be leveraged to conduct a secondary study or what data may be missing (Gough, Thomas, & Oliver, 2012). In response to this need, the social sciences have developed the systematic mapping methodology to incorporate the broad range of data that may be examined as outlined above (Clapton, Rutter, & Sharif, 2009; Oakley et. al., 2005; Bates, Clapton, & Coren, 2007). Documents such as the CPSE (2020) white paper, are considered grey literature as it is an example of a technical report produced by an agency outside academia / a commercial publication and designed to guide areas for future research and policy (New York Academy of Medicine, n.d.).

Developed and refined by the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre), Institute of Education, the mapping review is utilized to map out and classify existing literature on a particular subject (EPPI-Centre, 2006). Further, the mapping review aids in identification of gaps in literature for the purposes of informing additional primary research or review of existing research. The mapping review differs from the scoping review in that the outcome of a mapping review may or may not involve further research

(Grant & Booth, 2009). The scoping review on the other hand merely identifies existing literature and ongoing research on a particular topic.

Mapping reviews provide context using existing literature and identify gaps in the available research for further investigation (Grant & Booth, 2009). This type of research helps to categorize data in manners such as by population type or setting and theoretical perspective. It is also useful in determining what approach should be taken for more in-depth or additional research (Grant & Booth, 2009). As we previously identified literature from academic and nonacademic sources are available on the topic of firefighter sleep deprivation. The scope of literature available (peer-reviewed journals, trade journals, and grey literature) supports the use of a mapping review for this research.

Mapping reviews are criticized for their lack of depth when it comes to synthesis and analysis found in other approaches such as the meta-analysis or systematic review. They are sometimes regarded as oversimplified, potentially masking variations found within the studies examined. (Grant & Booth, 2009). These shortcomings can be mitigated by following more rigorous procedures such as those found in systematic mapping (James, Randall, & Haddaway, 2016). The research process outlined later in this document addresses the limitations of a mapping review as outlined in the extant literature.

Inclusion and Exclusion Criteria

This scoping review included peer-reviewed publications and other academic documents such as dissertations as well as fire service specific trade journal articles from the previous 5 years. Additionally, technical reports such as the 21st Century Fire and Emergency Services white paper and firefighter fatality reports produced by the National Institute for Occupational Safety and Health (NIOSH) were included in their totality. Although the American

Psychological Association (APA) does not provide an explicit timeliness requirement, it does require relevance including providing proper background information (Greenbaum, 2021). Based on convention, a timeframe of five years or less for academic and trade sources was selected to provide the most timely and relevant perspectives. The inclusion of the database of NIOSH investigations a historical context. The goal was to understand and outline the current trends in fire and emergency services regarding sleep and sleep deprivation as well as the depth and breadth of information available to inform decisions regarding sleep deprivation in fire and emergency services. There were no inclusion restrictions with regard to country of publication, although only articles written in English will be included. This is because there are intersections between global fire rescue services, and inclusion of this information allowed for a more comprehensive analysis of available resources.

Research Process

Kahn et al. (2003) describes five steps to conducting a systematic review which include framing the question, identifying relevant publications, assessing study quality, summarizing the evidence, and interpreting the findings. The first step, framing the research questions can be found in Chapter 1. These questions included:

1. What educational resources are currently available for firefighters regarding the importance of sleep and the effects of sleep hygiene?
2. What current research exists on the firefighter population regarding sleep deprivation?
3. What improvements could be made in terms of educating firefighters on sleep and sleep deprivation?

The second step involved locating relevant publications which will include a search of fire service specific publications as well as peer reviewed research articles. Databases such as the

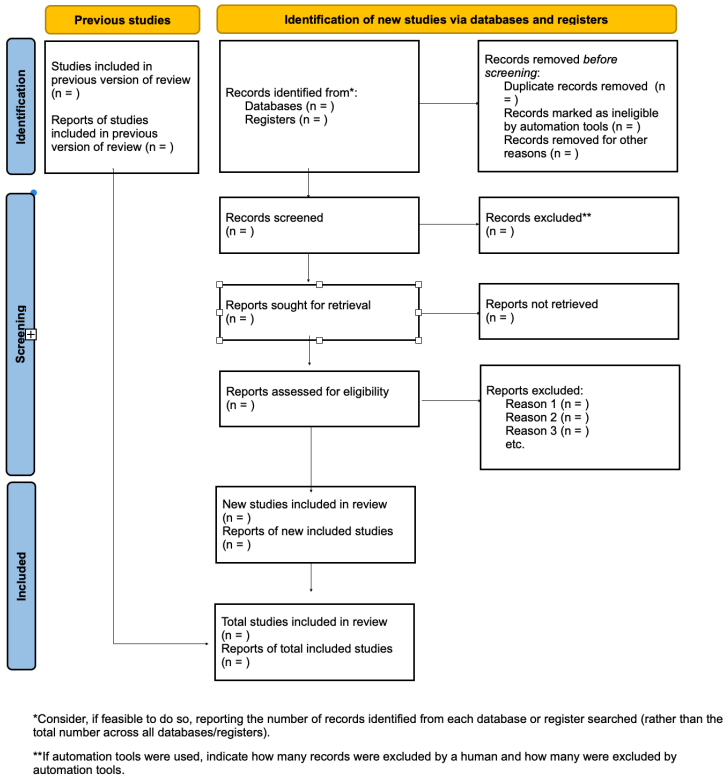
National Emergency Training Center library, EBSO Information Services, The and the Chicago School of Professional Psychology online library were leveraged to locate relevant publications. Additionally, organizations with specific emergency service interest such as NIOSH, and the Federal Emergency Management Agency (FEMA) will be searched for grey literature, such as technical documents and reports like firefighter fatality reports.

Articles were initially be screened by evaluating publication date and relevance using the title and abstract, categorized into one of three categories, academic publication, emergency services trade journal, or grey literature (technical reports, etc.). Following this, a review of the entire body of the article will ultimately determine relevance to either current mindset or available educational resource. If an article is questionable, it will be included in the review.

The third step focused on assessing study quality. Many fire service specific publications lack the academic rigor required of their peer-reviewed counterparts. Despite this, fire service specific publications and grey literature are considered relevant to the fire service community and are important for consideration in addition to peer reviewed counterparts. Inclusion of all three-forms of literature allowed for a more comprehensive understanding of the ecosystem of available resources and information.

Steps four and five called for summarizing and synthesizing the available literature and resources. These resources were be mapped to form connections and expose gaps in literature and educational resources. Following this, the synthesis of the map includes a summary of the available evidence and educational resources regarding sleep deprivation in the fire service as well as the gaps (if any) for further exploration.

Figure 1



PRISMA flowchart

(Page, et al., p. 1, 2020)

Ethical Considerations

According to Gough (2017) ethical considerations are not typically discussed explicitly in review type research. In contrast to primary researchers, researchers conducting review type research utilize publicly available information and do not collect personal or sensitive information from individuals. This type of research is typically exempt from Institutional Review Board approval in most educational settings (Suri, 2019).

Many educational researchers subscribe to the theories of virtue or obligatory ethics and consequentialism or utilitarianism when making ethical decisions. Virtue ethics is based in the idea of high moral standards and are important for researchers when considering the

stakeholders who will be using their research (Brooks et al., 2014). Consequentialism focuses on the teachings of Immanuel Kant regarding the idea that certain actions are not explicitly right or wrong and therefore the ends cannot justify the means. This is furthered by the guiding principles of do good, and prevent harm (Cohen et al., 2018). Thus, the ethical considerations necessary for conducing a literature review differ from those of a traditional human-subjects research study. This review incorporates these ethical ideas by considering how this information could be leveraged by the fire service.

Common in the fire service is the maxim "100 years of tradition unimpeded by progress" (Morse, 2012). Despite the evidence firefighters are accustomed to the 24-hour shift schedule and more persuasive is the time of associated with this type of schedule. This is evidenced by the push for longer shift durations which equate to longer stretches of days off such as the 48 hours of work followed by 96 hours off. Despite the evidence, firefighters are also likely to oppose schedule changes due to an anchoring bias which anchors their thought process in what they currently know.

There is also a cost savings associated with firefighter schedules. The Fair Labor Standards Act (FLSA) broadly implemented across the United States in 1985 (Varone, 2020) changes how firefighters' overtime is calculated from the average worker. This means a significant cost savings for fire departments when it comes to overtime. This may result in undue pressure from politicians with regard to how the evidence is interpreted or implemented.

Summary

A systematic or mapping review examined the existing literature and educational resources available on firefighter sleep deprivation. A broad range of available resources

including academic publications, emergency service specific trade articles, and grey literature including technical publications were systematically cataloged and synthesized utilizing best practices in systematic review.

CHAPTER 4: STUDY RESULTS

A keyword search of the databases outlined in Chapter 3 for "firefighter, sleep, deprivation" resulted in 235 publications. These resources were assessed for inclusion based on the inclusion criteria from Chapter 3 including timeliness and relevance. Based on these criteria, only ninety-five articles are included in this scoping analysis.

Introduction – Demographics of the Participants

Research was conducted in the following data bases to capture answers to the research questions posed in Chapter 1.

Q1: What educational resources are currently available for firefighters regarding the importance of sleep and the effects of sleep hygiene?

Q2: What current research exists on the firefighter population regarding sleep deprivation? What improvements could be made in terms of educating firefighters on sleep and sleep deprivation?

NETC Library

The website for the National Emergency Training Center Library describes the location as "your primary information resource for fire, emergency management, and other all hazards-subjects" (2022, para 1). Located on the campus of the National Fire Academy, the library is a resource for both the National Fire Academy, Emergency Management Institute, and other research programs.

EBSCO

EBSCO is described on their website as the "leading provider of research databases, e-journal and e-package subscription management, and book collection development and acquisition management" they go on stating they are a "major provider of library technology, e-

books and clinical decision solutions for universities, colleges, hospitals, corporations, government, K-12 schools and public libraries worldwide" (EBSCO, para. 1, 2023).

The Chicago School of Professional Psychology Library

Supporting the currently 30 programs offered by the Chicago School of Professional Psychology, the library known today as the "University Library" offers access to numerous resources supporting research into various academic pursuits. These resources include 300 different databases available through a single search portal known as "OneSearch". The online database is supplemented by librarians to assist with additional research inquiries (The Chicago School of Professional Psychology, 2023).

Firefighter Fatality Investigation Report

The NIOSH Firefighter Fatality Investigation and Prevention Program (FFFIPP) resulted from a 1998 call to action by Congress to address the nationwide problem of work-related firefighter deaths. The program conducts independent investigations of firefighter line-of-duty deaths and recommends methods to prevent future deaths and injuries. As an organization, the FFFIPP does not act as a public health organization nor does it enforce any health or safety standards or place blame with individual firefighters or fire organizations (NIOSH, 2023).

Research Results

NETC Library

A keyword search for "firefighter, sleep, deprivation" yielded 34 total results. Twelve EFO papers, 7 journal articles, 5 off print articles, 6 dissertations / thesis, 2 EMI academy papers, 1 DVD, and 1 report. Twenty-four resources were eliminated based on the date of publication.

The Executive Fire Officer Program (EFOP) at the National Fire Academy "provides you with leadership skills you can use to strengthen your organization and help make your

community more resilient" (FEMA, 2022). A graduation requirement from the EFOP is a capstone research paper which "is designed to challenge and expand executive minds as it relates to conducting thorough and responsible research to develop conclusions and recommendations based on empirical evidence (Executive Fire Officer Capstone Research Paper Guidelines, pg. 2, n.d.). Despite the use of a research process, EFOP Research Papers are not Peer Reviewed and are therefore considered grey literature but are highly regarded by the fire service. Capstone papers completed for the Emergency Management Institute's Emergency Management Advanced Academy follow similar requirements with similar outcomes. Of the seven papers that met the date requirements, of those, 5 met the relevance requirement and will be included in the study.

According to the Enago Academy (2022), a thesis is typically associated with graduation from a master's program while a dissertation is required for a doctorate. Both documents are considered academic resources due to the rigor required for completion, despite not being peer-reviewed. Of the 6 original dissertations / thesis available at the NETC Library, three met the date requirement. All three articles are included based on the relevance established in the abstract.

Firehouse magazine is a mainstream trade journal specific to the fire service. This resource serves as an intermediate resource that publishes topics relevant to the fire service. Based on the description from the University of Wisconsin - Madison Library website (n.d.), a trade journal as an "excellent source" to examine trends products, and topics important to a specific industry. This rationale was leveraged to include relevant topical source materials in the review.

Table 1

Articles for Inclusion from The National Emergency Training Center Library

Title	Author	Date	Topic	Type
Measuring Sleep Deprivation in Responders	Drayton, Daniel	2018	Sleep Hygiene	EFO
Better Sleep: how to alter your existing fire station to reduce sleep deprivation	Carter, Craig	2018	Mitigation	Trade Journal
Evaluating Sleep Habits Among Emergency Services Workers	Routson, Lance	2018	Sleep Hygiene	EFO
Proactive Stress Management for Firefighters	Mead, Amanda M.	2018	Mental Health	Article
Sleep Deprivation in the Fire Service	Sanderson, Tim	2019	Sleep Hygiene	EMI
Strategies to Improve firefighter mental health awareness in the Dayton Fire Department	Lykins, Jeff	2020	Mitigation	EFO

EBSCO

The same keyword search for "firefighter, sleep, deprivation" was used on EBSCO yielding 7 results. Of those 7 resources, 6 were eliminated based on the publication date. The remaining article was found in the NETC Library.

The Chicago School of Professional Psychology Library

One hundred six resources were found using the keyword search in the Chicago School of Professional Psychology online library. These results include 70 articles of which 45 are peer reviewed. Twenty results are newspaper articles. Ten dissertations. Four articles from various newsletters. One book chapter. Sixty of the original 112 results were eliminated based on the publication date leaving 40 articles for inclusion in this review.

Table 2

Articles for Inclusion from The Chicago School of Professional Psychology Library

Title	Author	Date	Topic	Type
The Impact of total sleep deprivation upon cognitive functioning in firefighters	Kujawski, Sławomir ; Słomko, Joanna ; Tafil-Klawe, Małgorzata ; Zawadka-Kunikowska, Monika ; Szrajda, Justyna ; Newton, Julia L ; Zalewski, Paweł ; Klawe, Jacek J	2018	Cognitive Functioning	Article
Researchers from Nicolaus Copernicus University Detail New Studies and Findings in the Area of Sleep Deprivation (The impact of total sleep deprivation upon cognitive functioning in firefighters)		2018	Cognitive Functioning	Newsletter
Posttraumatic stress, alcohol use, and alcohol use reasons in firefighters: the role of sleep disturbance.	Smith, Lia J. ; Gallagher, Matthew W. ; Tran, Jana K. ; Vujanovic, Anka A.	2018	Mental Health	Article
Adding sleep restriction to the equation: impact on woodland firefighters' work performance and physiology in hot conditions	Vincent, Grace E. ; Ferguson, Sally ; Larsen, Brianna ; Ridgers, Nicola D. ; Snow, Rod ; Aisbett, Brad	2018	Sleep Hygiene	Article
Well-being and Readiness to Change among Career Firefighters	Feinauer, Elizabeth R	2018	Sleep Hygiene	Dissertation
Better Sleep at the Station	Carter, Craig	2018	Mitigation	Trade Journal

Data on Occupational and Environmental Health Described by Researchers at Deakin University (Adding sleep restriction to the equation: impact on wildland firefighters' work performance and physiology in hot conditions)		2018	Physiology	Newsletter
Where Fire & EMS Cross	Ludwig, Gary	2018		Trade Journal
Associations between sleep disturbances, mental health outcomes and burnout in firefighters, and the mediating role of sleep during overnight work	Wolkow, Alexander P. ; Barger, Laura K. ; O'Brien, Conor S. ; Sullivan, Jason P. ; Qadri, Salim ; Lockley, Steven W. ; Czeisler, Charles A. ; Rajaratnam, Shantha M. W.	2019	Mental Health	Article
Sleep: A Missing Link in Cancer Prevention	Ali, Dena	2019	Physical Health	Trade Journal
Effects of a 72-Hour Work Shift on Stress Biomarkers in Sleep-Deprived Firefighters	Sundberg, Neil	2019	Shift Work	Dissertation
Managing Sleep, Health & Safety	Czeisler, Charles ; Barger, Laura ; O'Brien, Conor	2019	Sleep Hygiene	Article
STRESS: The Silent Killer of the EMS Career	Backberg, Hollie	2019	Mental Health	Trade Journal
An Action Inquiry to Address Career Burnout Syndrome within a Medium Sized Fire Department	Contreras, Rob	2019	Mental Health	Dissertation
The Effects of Live-Fire Drills on Visual and Auditory Cognitive Performance among Firefighters	Hemmatjo, Rasoul ; Hajaghazadeh, Mohammad ; Allahyari, Teimour ; Zare, Sajad ; Kazemi, Reza	2020	Cognitive Functioning	Article

Association between Shift Work and Neurocognitive Function among Firefighters in South Korea: A Prospective before–after Study	Kwak, Kyeongmin ; Kim, Bong-Kyu ; Jang, Tae-Won ; Sim, Chang Sun ; Ahn, Yeon-Soon ; Choi, Kyeong-Sook ; Jeong, Kyoung Sook	2020	Shift Work	Article
0223 Interactions Between Home, Work, and Sleep Among Full-Time Firefighters	Watkins, S L ; Shannon, M A ; Hurtado, D ; Shea, S A ; Bowles, N P	2020	Mental Health	Article
Fatigue and sleep patterns among Canadian firefighters during a 17-day fire line deployment	Jeklin, Andrew T. ; Davies, Hugh W. ; Bredin, Shannon S. D. ; Hives, Ben A. ; Meanwell, Leah E. ; Perrotta, Andrew S. ; Warburton, Darren E. R.	2020	Sleep Hygiene	Article
Hot, Tired, and Hungry: The Snacking Behavior and Food Cravings of Firefighters During Multi-Day Simulated Wildfire Suppression	Gupta, Charlotte C ; Ferguson, Sally A ; Aisbett, Brad ; Dominiak, Michelle ; Chappel, Stephanie E ; Sprajcer, Madeline ; Fullagar, Hugh H K ; Khalesi, Saman ; Guy, Joshua H ; Vincent, Grace E	2020	Physical Health	Article
Welcome to the 2020 Station Design Awards	Wilmoth, Janet	2020	Sleep Hygiene	Trade Journal
Stress in the Fire Service: Large Urban Fire Department: An Innovation Study	Miyagishima, Glenn	2020	Mental Health	Dissertation
284 Cognitive Deficits due to Insufficient Sleep are Mitigated Following Strenuous Physical Exertion in Firefighters	Stepan, Michelle ; Wilckens, Kristine ; Hostler, Dave ; Franzen, Peter	2021	Cognitive Functioning	Article
Sleep disturbance and cognitive functioning among firefighters	Stout, Jeremy W ; Beidel, Deborah C ; Brush, David ; Bowers, Clint	2021	Cognitive Functioning	Article
Daytime Sleepiness among Midwestern Firefighters	Shi, Yihe ; Bender, Bridget ; McGovern, Patricia ; Jung, Eun Mi ; DeMoulin, Douglas ; Jacobs, Samuel ; Prichard, J. Roxanne ; Kim, Hyun	2021	Sleep Hygiene	Article

The association between heart rate variability, reaction time, and indicators of workplace fatigue in wildland firefighters	Jeklin, Andrew T. ; Perrotta, Andrew S. ; Davies, Hugh W. ; Bredin, Shannon S. D. ; Paul, Dion A. ; Warburton, Darren E. R.	2021	Physiology	Article
An Exploratory Analysis of Firefighters' Nutrient Intake Related to Obesity, Musculoskeletal Injury, Sleep, and Physical Fitness	Johnson, Brittany Valine Barrans	2021	Physical Health	Dissertation
Firefighters Have Cerebral Blood Flow Reductions in the Orbitofrontal and Insular Cortices That are Associated with Poor Sleep Quality	Park, Shinwon ; Hong, Haejin ; Kim, Rye Young ; Ma, Jiyoung ; Lee, Suji ; Ha, Eunji ; Yoon, Sujung ; Kim, Jungyoon	2021	Physical Health	Article
Recovery Sleep versus Emotion Regulation in Predicting Fire Service Shift Workers Stress, Fatigue and Irritability	Kelly, Monica R. ; A. Hillier, Elizabeth ; Aria, Farzeen ; Gulotta, John ; Haynes, Patricia L.	2021	Mental Health	Article
The Cardiometabolic Health Benefits of Sauna Exposure in Individuals with High-Stress Occupations.	Henderson, Kaemmer N ; Killen, Lauren G ; O'Neal, Eric K ; Waldman, Hunter S	2021	Physical Health	Article
The Impact of shift work on the well-being and subjective levels of alertness and sleepiness in firefighters and rescue service workers	Nowak, Kamila ; Łukomska, Barbara	2021	Shift Work	Article
Cognitive functions of shift workers: paramedics and firefighters - an electroencephalography study	Sumińska, Sylwia ; Nowak, Kamila ; Łukomska, Barbara ; Cygan, Hanna B.	2021	Cognitive Functioning	Article

Researchers from Urmia University of Medical Sciences Publish New Studies and Findings in the Area of Global Health (The Effects of Live-Fire Drills on Visual and Auditory Cognitive Performance among Firefighters)		2021	Cognitive Functioning	Newsletter
Bringing Creditability to the Term “Combat Ready”	Reilly, Dennis	2021	Sleep Hygiene	Trade Journal
Findings from University of Pittsburgh Provide New Insights into Sleep Deprivation (Physical Exertion Partially Mitigates Task-switching Deficits From Sleep Loss Implications for Firefighters)	Stephan, M.; Wilchens, K; Hostler, D.; Wallace, M.; Franzen, P.	2022	Physical Functioning	Newsletter
Crosstalk opposing view: Insufficient sleep is not responsible for increased risk of metabolic disease in shift workers.	Bowles, Nicole P. ; Thosar, Saurabh S. ; McHill, Andrew W.	2022	Shift Work	Article
A framework and serious game for decision making in stressful situations; a fire evacuation scenario	Daylamani-Zad, Damon ; Spyridonis, Fotios ; Al-Khafaaji, Kamal	2022	Cognitive Functioning	Article
Station Design Conference Evolves with Current Trends		2022	Sleep Hygiene	Trade Journal
Phoenix Fire Honors January as Firefighter Cancer Awareness Month, Combating Sleep Deprivation		2023	Cancer	Newspaper
Intra-Tour Variation of Firefighter Sleep Duration and Sleep-Wake Cycle within the 24/48 and 48/96 Shift Schedules	Billings, Joel M. ; Haddock, C. K. ; Jahnke, S. A.	2023	Shift Work	Article

Firefighter Fatality Investigation Reports - NIOSH

Firefighter fatality reports are available online through the NIOSH website dating back to 1985. The search results for the keywords "firefighter, sleep, deprivation" yielded 47 results out of 703 total completed reports. Interestingly the first citing was in 2000, indicating sleep deprivation was not considered a possible contributing factor to firefighter fatalities until that date.

Table 3

Completed Firefighter Fatality Reports for Inclusion

Title	Report Number
Sector Captain Suffers Fatal Heart Attack - Texas	F2000-12
District Chief Dies of a Stroke After Serving as the Incident Commander at a Structure Fire - Tennessee	F2000-30
Fire Fighter Dies After Returning from Mutual-Aid Fire Call - Connecticut	F2001-14
Fire Fighter Dies in Sleep During His Work Shift - Michigan	F2001-21
Fire Fighter Dies in Sleep During His Work Shift - Michigan	F2001-21
Fire Fighter Dies During the Night At Fire Station - Missouri	F2002-27
Fire Fighter Dies During the Night At Fire Station - Missouri	F2002-27
Fire Fighter Dies During Night at Fire Station - Mississippi	F2003-01
Fire Fighter Suffers Sudden Cardiac Death At His Fire Station - Oregon	F2003-26
Fire Fighter Suffers Sudden Cardiac Death After Emergency Recall - Massachusetts	F2004-08
Fire Fighters Suffers Fatal Pulmonary Embolism after Knee Surgery for a Work-related Injury - North Carolina	F2004-13
Volunteer Fire Fighter Suffers Sudden Cardiac Death After Participating in Emergency Responses - Maryland	F2004-18
Probationary Fire Fighter Suffers Sudden Cardiac Death During Maze Drill - Connecticut	F2004-38
Fire Chief Suffers Sudden Cardiac Death After Responding to a Motor Vehicle Crash – Texas	F2005-08
Captain Suffers Pulmonary Embolism During Response to a Medical Call and Later Dies - New York	F2005-33

Lieutenant suffers on duty cardiac death at a Regional Dispatch Center - Ohio	F2011-07
Fire Fighter Suffers On-Duty Sudden Cardiac Death – Missouri	F2011-11
Wildland Fire Fighter Dies from Hyperthermia and Exertional Heatstroke While Conducting Mop-Up Operations - Texas	F2011-17
Career Lieutenant Dies After Being Trapped in the Attic After Falling Through a Roof While Conducting Ventilation – Texas	F2011-20
Engineer Dies from Heart Attack and Cardiac Arrest – Indiana	F2011-29
Career Lieutenant and Fire Fighter Killed and Two Fire Fighters Injured by Wall Collapse at a Large Commercial Structure Fire - Pennsylvania	F2012-13
Lieutenant Suffers Fatal Heart Attack During a Fire in a Commercial Structure – New York	F2012-16
Fire Marshal Suffers Cardiac Arrest and a Probable Heart Attack during a Fire Department Physical Ability Test – Utah	F2012-18
Fire Marshal Suffers Cardiac Arrest and a Probable Heart Attack during a Fire Department Physical Ability Test – Utah	F2012-18
Captain Dies from Hyperthermia and Exertional Heatstroke While Performing Advanced Survival Training - Texas	F2012-27
Driver/Engineer Suffers Sudden Cardiac Death at Scene of Motor Vehicle Crash – Georgia	F2013-18
Fire Fighter Suffers Sudden Cardiac Death While Responding to Residential Structure Fire – Michigan	F2013-20
30-Year-Old Lieutenant Dies in Sleep Following Department Training—Vermont	F2019-05
29-Year-Old Firefighter Suffers Cardiac Arrest After Two 24-hour Shifts—Wisconsin	F2019-06

Firefighter Near Miss Reporting System

According to the Near Miss (2023) website, “A near miss event is defined as an unintentional unsafe occurrence that could have resulted in an injury, fatality, or property damage if not for a fortunate break in the chain of events”. Beginning in 2005, the [Firefighter] Near Miss Reporting System is a voluntary, self-report system managed by the International Fire Chief’s Association that captures data about the contributing factors to incidents and near-miss

incidents involving firefighter injuries (Near Miss, 2023). The data is used to create weekly reports distributed to a subscription based electronic mailing list as well as other training resources. Data is also compiled to help identify trends in firefighter health and safety.

A search of the Near Miss Reporting System database returned no results for the keywords “firefighter, sleep, deprivation”. Separating the key words, 23 self-reports published between 2005 and 2017 were returned for the keyword “sleep." Two reports resulted from a search for the word “deprivation”, those two were previously found for the word sleep.

The Near Miss organization also publishes annual reports however these are difficult to find either on their website or the world wide web as a whole. Searches of both the website and the world wide web revealed annual reports for the years 2006, 2007, 2008, and 2016. Keyword searches of these reports returned zero results for “firefighter, sleep, deprivation.”. Due diligence reviews of these publications revealed the use of the term “fatigue” in place of sleep deprivation. Fatigue was cited as a contributing factor in an average of 3.8% of the reports. Given the timeliness of these reports, they are not included in this scoping review.

Other Technical Publications

The Center for Public Safety Excellence (CPSE) is a non-profit organization that aids fire departments and public safety professionals with continuous improvement of service delivery. (CPSE, 2022). In 2018, the CPSE partnered with the International County/City Management Association (ICMA) to create a document outlining the future of fire and emergency services titled 21st Century Fire and Emergency Services. The document addresses a wide-variety of topics including inclusiveness and diversity, health and wellness, culture, and technology. Contained in the Health and Wellness section is “Initiative 1: Champion research on the health

impacts specific to the fire and emergency services to evaluate the health risk of consecutive hours worked, sleep disruption, and the impacts on employee health" (CPSE, 2020, pg. 16).

The International Fire Chief's Association (IAFC) is a representative body of leadership for fire and emergency services organizations providing vision and representation to enhance professionalism and capability. In 2007, the organization in partnership with the USFA authored a report titled *The Effects of Sleep Deprivation on Firefighters and EMS Responders* (IAFC & USFA, 2007). Following the report, a computer-based training program was also introduced which included information on normal sleep physiology and the health performance effects of sleep deprivation. Also included were risk factors for sleep deprivation and associated countermeasures and strategies for mitigating sleep issues (IAFC, 2022). Although this document was authored in 2007, search results reveal this is the most up to date educational program on sleep deprivation for fire and emergency services personnel.

Resulting Themes

Sleep deprivation is a more contemporary concern for the fire service evidenced by its absence from fire fatality contributing factors for the first 15 years of investigation publications (1985-2000) but gaining in prevalence in the last 20 years (since 2000). Sleep deprivation is also found in Executive Fire Officer Program capstone papers beginning in 2000 as well. The relevance of the concerns caused by sleep deprivation were highlighted by the IAFC publication *The Effects of Sleep Deprivation on Firefighters and EMS Responders"* in 2007 which is the most comprehensive document on sleep deprivation specific to firefighters and other emergency services workers found during this review. The effects of sleep deprivation are renewed by inclusion in the CPSE *21st Century Fire and Emergency Services* white paper. Through the scoping review process, two primary themes emerged, research highlighting specific concerns

resulting from firefighter sleep deprivation and a call to action to address sleep deprivation and sleep hygiene in the American Fire Service. As a result of the analysis of the 95 publications chosen for inclusion in this scoping analysis the following themes emerged: Mental Health, Physical Health, Cognitive Functioning, Shift Work, Sleep Hygiene.

Summary

Sleep is a basic requirement for human existence. The body requires it for countless processes to maintain a state of homeostasis. The traditional firefighter schedule and resulting disruptions in normal sleep function may be causing more harm to the American fire service than it realizes as demonstrated by the literature (and lack thereof). The next chapter will delve deeper into each of the theme emerging from this scoping review.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

At the base of the well-known hierarchy of needs published by Abram Maslow (1943) are basic human physiological needs which include sleep. Searches of six academic and fire service specific databases yielded ninety-five publications to be included in this scoping review on the topic of firefighter sleep deprivation. The publications included in this review in five primary themes: Mental Health, Physical Health, Cognitive Functioning, Shift Work, Sleep Hygiene. In this final chapter is a discussion of the broader literature supporting the importance of sleep and the detriments of sleep deprivation specific to the fire service.

Summary of the Results

According to the National Sleep Foundation, more than one-third of American adults do not get the recommended 7.5 to 8 hours of sleep each night (Sun, 2002; US Department of Health and Human Services, 2011). Regular sleep patterns are linked and synchronized with the day-night cycle also known as the circadian rhythm. An imbalance exists between sleep and waking hours The average adult requires between 6 and 10 hours of sleep each day with a biological preference for sleep during the nighttime.

Sleep is composed of two different stages, non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. When sleep begins, human experience NREM, which is composed of 4 substages of sleep categorizing progressively deepening levels of sleep. Following the slowing of metabolic processes including heart and respiratory rate associated with the 4th stage of NREM sleep is REM sleep. While 75 percent of the normal sleep cycle is NREM sleep and 25 percent REM, adequate amounts of both are necessary for healthy human function. Disruptions in the normal sleep cycle including awakening during specific periods of sleep or inadequate

overall sleep duration or quality have been tied to numerous physical and mental health concerns as well as being associated with decreased cognitive functioning.

The literature supports these assertions in the general human population as well as specifically for firefighters. Barros et al. (2012) describe the sleep deprivation of firefighters as unique when compared to the general population.

The majority of academic sources including both peer-reviewed, as well as fire service specific literature (e.g., EFO papers), cited the importance of sleep and the negative effects of sleep deprivation. Sleep is an essential to maintaining homeostasis. It provides for rehabilitation from the stresses experienced both physically and mentally, boosts creativity and positivity. Sleep is even tied to immune health and sleep deprivation is tied to diseases such as cancer, obesity, diabetes, addiction, cognitive dysfunction, and mental illnesses (Adan, 2012; Aran et al., 2016; Chung, Wolf, & Shapiro, 2009; Kamphuis et al., 2016; Quan, 2008; Stubbs et al., 2016; Tobaldini et al., 2017; Walker, 2017). An individual's ability to compensate for irregular or insufficient sleep is based upon their biological makeup (Sun et al., 2016). Despite this assertion, irregular and insufficient sleep will have a negative effect on everyone at some point. Despite popular opinion, sleep debts cannot be repaid by future sleep (Walker, 2017) making a regular sleep routine essential. Herein lies the problem presented to firefighters, emergencies happen 24-hours a day at any point without prediction. The current response model and shift scheduling for firefighters providing continuous response capability comes at a sacrifice for firefighters, sleep.

Mental Health

Sleep is tied to mood specifically perception and emotion (Walker, 2017). Poor sleep has been found to impact affective response in both healthy and mood-disordered patients (O'leary et al., 2016). According to Krantz, Thorn, & Kiecolt-Glaser (2017) studies show that stress is also

related to sleep and can contribute to a variety of negative health outcomes, including: cardiovascular disease, anxiety, depression, and obesity. Vargas & Lopez-Duran (2017) performed a between-groups quantitative study of sleep deprivation and blood levels of the stress hormone cortisol finding that cortisol seems to be influenced by sleep. As a result of the work performed by firefighters and other emergency services personnel itself, the stresses associated with the job contribute to the quality of sleep experienced by firefighters both on- and off-duty. (Barros et al., 2012). The aforementioned study also found that alcohol abuse and suicidal ideation are related to firefighter sleep disturbance and issue of growing concern. These assertions are supported by Henderson, Hasselt, Leduc, & Couwels, (2016) as they describe substance abuse and mental health stigmas in the fire service that leave the growing problems unchecked due to unwillingness to seek help.

Eight articles included in this scoping review reveal an association between mental health and sleep. Mead (2018) was the only article found to proactively address mental health through improved sleep hygiene. The remaining articles discuss the concerns relating mental health disturbances with sleep deprivation. This ties in directly with the second initiative listed under Health and Wellness in CPSE (2020) to "Proactively address the increased mental health challenge(s) facing fire and emergency services" (pg. 17). This review highlights the importance of why understanding the link between mental health and sleep deprivation is critical for emergency response wellness.

Physical Health

Five articles examined resulted in themes surrounding physical health. In addition to the mental health benefits of sleep discussed above, sleep is also necessary for restoration and repair of the body's systems (Walker, 2017). Firefighting is a physically demanding job. The literature

examined creates an assumption that firefighters understand the importance of exercise, nutrition, hydration, occupational physicals and routine medical exams but the question remains, do they understand the importance of sleep. Firefighters are more susceptible to cardiac events than any other occupation (Kay, Lund, Taylor, & Herbold, 2001). The category of "stress and overexertion" remains the leading cause of firefighter fatalities for over the last two decades.

Sleep deprivation is tied to atherosclerosis, hypertension, and myocardial infarction according to a systematic review by Tobaldini et al. (2017). Further these authors found that people who routinely got inadequate sleep suffered higher rates of cardiovascular and metabolic disease compared with those who regularly got adequate sleep. As a conclusion, Tobaldini et al. (2017) advocated for early detection of sleep disorders as a method of prevention and mitigation of such risk factors. With cardiac and "stress and overexertion" being the leading cause of firefighter line of duty deaths, it begs the question, is there a link to sleep?

Cognitive Functioning

Disturbances in sleep have been shown to impact the mental capacity and are tied to an increased risk of neurological disorders including Alzheimer's disease (Walker, 2017). Seven results of this scoping review indicate sleep deprivation causes an adverse impact on cognitive function. These assertions are supported by (Aran et al., 2016; Kamphuis et al., 2016; Tucker et al., 2010; Walker, 2017) who tout a decreased cognitive function, decreased working memory, increased impulsivity, and overall lack of executive functioning associated with sleep deprivation. Since firefighters are often faced with the necessity of quick decisions that can have mortal risk, these assertions should raise significant concern.

Shift Work and Sleep Hygiene

Sleep disturbances for firefighters are difficult to describe because their sleep is influenced by many factors atypical from the general population. Most obvious are work schedules that differ from the typical Monday - Friday 9 to 5 ("What Are the Typical, 2017). Though many fire departments enforce limits on consecutive time worked, "typical" firefighter shifts are long, and rest periods are contingent on emergency call volume, as well as routine daily duties including public education /relations, training, and maintenance and upkeep of firehouses and equipment. Given these demands on firefighters, the ability to compensate for a poor night's sleep is an ineffective endeavor and the effects of a single night's sleep disturbances will have a lasting effect (Walker, 2017).

Twelve articles examined in this scoping review highlight sleep hygiene or shift work. Two of the twelve articles are publications of trade journals touting fire station design. These articles could arguably be biased to sell specific features, technologies, or products to "improve sleep" but none provided peer-reviewed evidence to support their products. Interestingly, an article by Bowles, Thosar, & McHill (2022) offers a contrary opinion regarding the association between metabolic disease and sleep deprivation. For instance, these authors argue that weight gain in shift workers is due to an increased window of opportunity to consume food as a result of shorter sleep durations found in shift workers. They go on discussing the idea that metabolism is optimized early in the standard day and weight gain can be attributed to a decrease in metabolic activity later in the day when shift workers consume most of their calories. Although a shorter sleep duration results in sleep deprivation, it is not the sleep deprivation itself that is the root cause.

Conclusions Based Upon Your Results

The CPSE *21st Century Fire and Emergency Services* white paper highlights the importance of addressing concerns regarding sleep for fire and emergency services personnel in the future. CPSE (2021) cites sleep deprivation, along with daily exposure to tragedy, and toxic environments, as a potential contributing factor to cancer and other health-related events, psychiatric disturbances, and suicide prevalence among members of the fire service. The publication calls for the fire and emergency services to "champion research on the health impacts specific to fire and emergency services to evaluate the health risk of consecutive hours worked, sleep disruption, and the impacts on employee health" (CPSE, pg. 16, 2021). The next call to action by this publication is a proactive approach to addressing increased mental health challenges followed by initiatives that advocate for overall wellness of fire and emergency services employees. The literature examined in this scoping review ties each of these goals to better sleep and a more comprehensive understanding of sleep hygiene in the context of emergency response.

Firefighters are shown to experience sleep deprivation at higher rates than other occupational classifications (Barros et al., 2012). As illustrated by this scoping review, there is limited research on sleep deprivation as it relates specifically to the fire service. The *21st Century Fire and Emergency Services* publication specifically issues a call for action to address sleep deprivation in fire and emergency services and appropriately calls for more research to inform policy modifications as necessary.

Limitations

As a result of a keyword search for "firefighter, sleep, deprivation" in 6 academic and fire service specific databases 95 publications were included in this scoping review. Unfortunately,

47 of those publications are firefighter fatality investigation reports that mention sleep deprivation as a possible contributing factor to the incident but do not elaborate further. So, despite illustrating sleep deprivation as a possible problem for the fire service, these reports do little to add to the specific evidence. This left48 articles contributing to the evidence of sleep deprivation as a concern for fire and emergency services personnel.

Implications and Recommendations to the Field

Evidence ties sleep deprivation to increases in mental and physical health disturbances. Examination of firefighter fatality causation and the literature shows a link between sleep deprivation (as a contributing factor) and the leading causes of firefighter death including "stress and overexertion" and "responding to or returning from alarms".

Based on the paucity of research and the trade journal publications available, it was apparent that there is not a lot of evidence-based guidance for firefighters and fire departments seeking information on sleep deprivation and its relationship to firefighter safety, health, and wellness. More importantly, the lack of available and clear resources points to some challenges in educational materials.

Recommendations for Future Research

In addition to the call for further research by CPSE (2020) on firefighter sleep deprivation and its associated effects, it is important to consider the following. Firefighters and other emergency services workers are faced with immense stress and pressure in the discharge of their duties. These conditions and experiences can contribute to PTSD which is common in the fire service (Henderson et al., 2016; Kehl, Knuth, Hulse, & Schmidt, 2014; Wagner, McFee, & Martin, 2010). Evidence indicates those suffering from PTSD also suffer from sleep disturbances often associated with nightmares. Sleep therapy is indicated for those with PTSD (Straus et al.,

2015) given the impacts of PTSD on sleep. Koffel, Polusny, Arbisi, & Erbes (2013) conducted a study on National Guard troops finding that those who suffered poor pre-deployment sleep were more likely to be diagnosed with PTSD upon their return. These findings are particularly relevant for firefighters and others in emergency services given the prevalence of sleep deprivation coupled with extreme stress they face. Further the lack of mention of PTSD (not a prevalent theme) illustrates the need for further exploration.

Conclusion

Public safety workers such as firefighters and other emergency services workers \ serve the community, making the issue of health for this particular population a priority, given the importance of their role for the entire community. A primary concern for the health and well-being of these civil servants is sleep deprivation, which this scoping review and associated supporting literature has illustrated is a real concern. Sleep deprivation contributes to the leading causes of morbidity and mortality of firefighters; therefore, this work highlights an important need for continued research and access to evidence-based educational resources for fire departments nationwide.

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