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Sleep Deprivation and the Health of Firefighters

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The Clinical Research Project is a graduation requirement for MSW students at St. Catherine University – The University of St. Thomas School of Social Work in St. Paul, Minnesota and is conducted within a nine-month time frame to demonstrate facility with the basic social research methods. Students must independently conceptualize a research problem, formulate a research design that is approved by a research committee and the university Institutional Review Board, implement the project, and publicly present the findings of the study. This project is neither a Master's thesis nor a dissertation.

Abstract

As public safety workers, the wellbeing of firefighters is of concern to the entire community. One of the primary work-related health issues facing firefighters is sleep deprivation, which can contribute to an array of health problems, including: mental illness, metabolic disease, and cardiovascular disease. The aim of this exploratory, quantitative research study was to gather preliminary data regarding the health of professional firefighters, with a focus on sleep. Data was collected from several Midwestern, metropolitan fire departments via an online survey. Sleep-deprived participants were identified using the Epworth Sleepiness Scale (ESS), as well as self-reports of average sleep onset latency, and hours of sleep achieved on-duty/off-duty. Firefighters' ESS score groups were found to be significantly related to cardiovascular disease, obesity, and their company assignments. Older firefighters were found to have higher ESS scores than younger firefighters. Between-groups analysis identified those who were assigned to Medic Units as having the highest ESS scores and rates of cardiovascular disease. Firefighters reported fewer mental health and Substance Use Disorder (SUD) diagnoses than the general population. While firefighters value and attend to their physical health and fitness, stigmas are still prevalent in the fire service that may be standing in the way of their recognizing and treating various behavioral health problems. Future studies should examine the ways that social workers could use physiological health topics, like sleep, as a means for addressing more stigmatized mental health issues in the fire service.

Keywords: Firefighters, Sleep, Epworth Sleepiness Scale, Mental Health

Sleep Deprivation and the Health of Firefighters

Sleep is a universal human experience and has long been the subject of inquiry and commentary. However, until well into the twentieth century, sleep was undervalued and underrepresented in science and medicine (Stickgold & Walker, 2009). Since becoming the focus of more formal scientific inquiry, sleep has been identified as integral in all aspects of health and wellness (Walker, 2017). It has even become a trendy topic in popular culture in recent years. Self-help literature targets a sleep-deprived audience, promising transformative results: “*Sleep Soundly Every Night, Feel Fantastic Every Day: A Doctor’s Guide to Solving Your Sleep Problems; The Sleep Revolution: Transforming Your Life, One Day at a Time; Sleep Smarter: 21 Essential Strategies to Sleep Your Way to a Better Body, Better Health, and Bigger Success*” (Huffington, 2017; Rosenberg, 2014; Stevenson, 2016). While these promises may seem to be too good to be true, they are based in reality. There isn’t an aspect of health or wellness that cannot be improved by improving one’s sleep, and conversely, sleep deprivation can contribute to an array of health problems, including: cardiovascular disease, mental illness, addiction, metabolic disease, and cancer- to name a few (Aran et al., 2016; Kamphuis et al., 2016; Martindale, Morissette, Rowland, & Dolan, 2017; O’leary et al., 2016; Tobaldini et al., 2017; Walker, 2017; Wannamethee, Papacosta, Lennon, & Whincup, 2016; Watling et al., 2016). Still, while sleep health has gained the attention of the more proactive and health-conscious, it continues to be undervalued in the West, both socially and in formal healthcare models (Johnson, 2017; Quan, 2008; Walker, 2017). In fact, recent studies show that about two-thirds of all adults in developed nations are not getting enough sleep; that is to say, on average, they are sleeping less than the 7-9 hours a night that is recommended for adults by the World Health Organization and National Sleep Foundation (Walker, 2017).

Sleep impacts the body, mind, emotions, and experiences of every human being, and yet many continue to sacrifice sleep to meet the demands of today's fast-paced society. One group that can experience sleep deprivation more frequently than most is that of full-time, professional firefighters. As shift workers, professional firefighters keep odd hours and erratic sleep schedules. Unlike other shift workers, however, professional firefighters work entire days at a time, responding to emergencies both day and night. These long and erratic shifts, coupled with off-duty scheduling demands, make it nearly impossible for firefighters to adjust to consistent sleep schedules. Lack of enough consistent, quality sleep can have a very negative impact on the health of firefighters and may predispose them to an array of biopsychosocial illness, including: obesity, depression, and addiction (Walker, 2017). However, little research has been done within the firefighter population and many of the health concerns of firefighters are not yet fully understood. Firefighter culture is distrustful of outsiders, making the firefighter population difficult to access (Jahnke, Poston, Jitnarin, & Haddock, 2012). Further, many of their behavioral health issues go unrecognized and/or untreated, as behavioral health continues to be stigmatized in the fire service (Gulliver et al., 2018). To summarize: while firefighters' erratic sleep schedules may predispose them to disease, their distrust of outsiders and cultural stigmas regarding behavioral health may be standing in the way of their being treated for it.

Sleep is a universal need; it is not threatening to talk about. Sleep health may be the key to accessing the firefighter population and addressing stigmatized health issues. As emergency workers, the health of firefighters and other first responders is of public concern. With sleep serving such an important role in health and well-being, and firefighters experiencing disturbed sleep on a regular basis, it is of social interest to examine the way that the sleep of these emergency workers may be related to their health. There are two purposes of this exploratory

study. The first is to gain a fundamental understanding of firefighter sleep. The second: to identify ways in which social workers may use sleep health to introduce more stigmatized topics (like behavioral health) in the firefighter population.

Literature Review

Sleep is an essential function of the body. Sleep allows for the body's rest, repair, and functioning from cellular to systemic levels (Walker, 2017). There is no aspect of health that is unaffected by sleep. Sleep serves a role in the body's maintenance of homeostasis. It is rehabilitating and energizing. It aids in the process of learning, boosts creativity, and promotes positivity. Sleep even supports immune health. Thus, sleep deprivation can contribute to a variety of health issues, including cardiovascular disease, cancer, diabetes, obesity, addiction, cognitive dysfunction, and mental illness (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). While each person has a unique biological make-up that influences how they process and adjust to erratic sleep schedules (Suh et al., 2016), it is clear that sleep deprivation can have a profound and lasting effect on everyone. As sleep debts cannot be satisfied by future compensation (Walker, 2017), an eight-hour sleep opportunity must be viewed as an essential daily (nightly) function and should not be compromised. However, since emergencies happen both day and night, and firefighters must always be ready to respond to alarms, it may be necessary to find other ways to meet the sleep needs of these emergency workers.

The Fire Service

Professional firefighters experience a type of sleep disturbance that is very difficult to describe, as their sleep can be influenced by several factors. Their work schedules are often inconsistent with a typical, Monday through Friday work week ("What Are the Typical," 2017),

and although most fire departments place safety restrictions on the number of consecutive hours their firefighters can work (National Fire Protection Association, 2017), shifts are nevertheless long: spanning from many hours to several days. Further, on-duty professional firefighters' ability to sleep at night is conditional upon the volume of emergency calls received during any given shift. They are also kept busy during the day, tending to both emergency and non-emergency duties, such as fire prevention and education, company training, and community engagement. Because of this, firefighters may not be able to compensate during the day for a night of disrupted sleep. Even if firefighters are able to nap or sleep in later on days following a busy night, research shows that attempts to compensate for lost sleep can be ineffective, as sleep deprivation has a lasting effect (Walker, 2017). These findings are problematic for emergency workers doing shift work. The volume of work firefighters encounter during their shifts varies greatly and is unpredictable. They must always be ready to respond, and as is the nature of emergencies, their work is stressful. Firefighters respond to a wide range of incidents, including, but not limited to: fires, explosions, terrorist events, mass-casualty incidents, high-angle/confined space/technical rescues, hazardous materials emergencies, medical emergencies, motor vehicle accidents/extrications, ice/water rescues, and natural disasters (Saint Paul Fire Department, 2017; Minneapolis Fire Department, 2016). They work under very intense, stressful, and dangerous conditions, whether they are well rested or not.

Similar to the ways that emergency work can negatively impact the quantity of sleep firefighters get while on duty, the stressful nature of firefighting may also negatively impact their sleep. In their study of 303 Brazilian firefighters, researchers found that 51% of the firefighters experienced sleep disturbances and that psychological distress and psychosomatic disturbances were significantly predictive of sleep disturbances among this population (Barros et al., 2012).

Further, Barros et al. found that alcohol abuse and suicidal ideation were also related to firefighters' disturbed sleep. These findings bring attention to two important issues. First, these findings indicate a substantial problem in the fire service with sleep, and second, they lend support to the growing concerns of the National Fire Protection Association (NFPA) regarding the problems of substance use and suicide in the fire service (Henderson, Hasselt, Leduc, & Couwels, 2016; NFPA, 2016). Further complicating the issue are the stigmas placed on mental health and substance use in the fire service, which possibly delay the identification of mental illness and/or addiction problems and discourage firefighters from seeking help when they need it. In their 2016 study of firefighter suicide, Henderson et al. found that firefighters are both more likely to suffer from suicidal ideation than workers from other professions and less likely to seek help.

Along with mental health issues, the NFPA and other fire service leadership organizations, including the International Association of Fire Fighters (IAFF), have identified cancer and cardiovascular disease as the most common health hazards to professional firefighters. While inherently different in many ways, each of these significant health issues that firefighters face shares a common link: the risk of each is increased with insufficient sleep (Walker, 2017). As there are no aspects of human health that do not benefit from improved sleep, there is much hope for combating these serious health problems in the fire service by improving firefighters' sleep.

Sleep and Cognition

Sleep disturbances negatively impact mental capacities and neurological health in both the short-term and long-term. While sleep disorders such as Sleep Apnea have been found to place an individual at a higher risk of developing such neuro-cognitive diseases as Alzheimer's

(Walker, 2017), sleep deprivation has been found to cause immediate cognitive deficits, including: decreased cognitive functioning, decreased working memory, increased impulsivity, and overall lack of executive functioning (Aran et al., 2016; Kamphuis et al., 2016; Tucker et al., 2010; Walker, 2017). These cognitive functions are conducted in the prefrontal cortex, the portion of the brain that is responsible for higher-level thinking. When the prefrontal cortex is compromised, so is judgment. Firefighters need to be able to make quick decisions, often facing risks to the lives of themselves and others. In this regard, the findings of a 2016 rodent study, unfortunately, do not bode well for sleep-deprived firefighters or the communities they serve. In their study of sleep deprivation on the operant behavior of rats, researchers discovered that sleep-deprived rats demonstrate deficits in the functioning of their pre-frontal cortexes (Kamphuis et al., 2016). The rats in the Kamphuis et al. study were trained in a lever-pressing/reward task and reached a level of mastery before being restricted to four hours of sleep a night, for seven days. Then their performances on the mastered task were measured, yielding results that indicated a marked decline in performance after sleep deprivation. Specifically, these rats demonstrated higher impulsivity, disinhibition, and lack of awareness to time when performing the task; all characteristic of a lack of necessary executive function for which the prefrontal cortex is responsible. As these findings come from a rodent study, their generalizability to human beings is, of course, limited. Nevertheless, similar findings have come from sleep studies of human subjects.

The results of a 2010 sleep deprivation study resulted in findings that indicated a significant decrease in executive functioning among subjects who were completely deprived of sleep overnight when compared with subjects who were not (Tucker et al., 2010). Similarly in a 2016 comparison study, pediatric residents of two Jerusalem-based hospitals worked overnight

shifts under varying napping conditions (Aran et al., 2016). Researchers found that the residents in the sleep deprived condition made poorer decisions than those who had rested. Much like professional firefighters, these residents' decisions can come with life-or-death consequences. The researchers concluded that it is imperative to allow for a minimum of a one hour nap during an overnight shift to support good decision-making. The results of these studies indicate the importance of achieving adequate sleep in promoting good executive function.

While Aran et al. found that quantity of sleep impacts cognitive functioning, a study of combat veterans examined the importance of sleep quality as it influences brain health. In their study of the impact of sleep quality on the cognitive functioning of combat veterans, Martindale, Morissette, Rowland and Dolan (2017) found that sleep quality affected cognitive functioning independent of the participant's exposure to combat or history of a mild traumatic brain injury (mTBI). Further, Martindale et al. found that quality of sleep affected the combat veteran's cognitive functioning both independent of and in addition to a diagnosis of post-traumatic stress disorder, or PTSD. The findings of these studies indicate the importance of developing interventions aimed at improving both sleep quality and quantity to promote good cognitive functioning. This research seems particularly significant for those with a PTSD diagnosis and/or who work in high-stress environments, like firefighters.

Sleep and Mood

It is evident that poor sleep can have negative health implications. Like the way that sleep impacts cognitive functioning, it influences perception and emotion (Walker, 2017). In a between-groups study of sleep as it relates to mood, (O'leary et al., 2016) researchers found that poor sleep quality negatively influenced the affective responses of both healthy and mood-disordered participants. The study examined the affective responses of participants to three types

of daily events (positive, neutral, and negative) following a night of poor quality sleep. The findings of the O'Leary et al. study support that poor-quality sleep has a negative impact on one's affect, particularly in persons with depressive mood disorders. Poor sleep was associated with a dulled response to neutral events and an increased negative affective response to negative events in persons without a mood disorder, where participants with a depressive mood disorder experienced enhanced negative affective responses to all three types of events. Similarly, another between-groups study found that activity in the amygdala (an area of the brain involved in emotional reactivity) of sleep-deprived participants was significantly higher than that of the well-rested when viewed under *f*-MRI imaging (Walker, 2017). The findings of these studies have strong psychosocial implications, particularly for individuals who are struggling with depression. Poor sleep can negatively impact an individual's perception of the world and lead to misinterpretation of, or overreaction to, one's experiences and social exchanges.

Another examination of the relationship between sleep and mood yielded evidence of a bi-directional relationship between the two. In their 2016 study, Watling, Pawlik, Scott, Booth, and Short suggest there are other variables involved in the complex relationship between sleep and mood. These researchers identify emotion and emotional regulation as key components in affective expression, or mood. Based on the findings of their study, Watling et al. (2016) propose that emotion serves as a mediator between sleep and mood, where sleep influences emotion, which in turn influences mood. Additionally, emotional regulation is identified as a moderator between emotion and mood. Sleep is relevant in this regard because Watling et al. (2016) also propose that there is a positive relationship between sleep and emotional regulation. These findings suggest that getting enough quality sleep is key to emotional regulation and

wellbeing. In this sense, chronic sleep deprivation could have long-term mental health implications.

Research supports that sleep deprivation is related to the very serious issue of suicide. A study conducted by Stubbs, Prina, Leng, and Cosco (2016) supports a possible relationship between sleep deprivation and the increase in firefighter suicide rates, particularly among firefighters suffering from pre-existing mental illness. In their 2016 study, Stubbs et al. found that sleep disturbance increased suicidal ideation and attempts among individuals with underlying mental illness, including: depression, anxiety, and substance use disorders. These findings were significant, even after controlling for participants' use of psychiatric medications. Further concerning are the ways that mental illness and addiction problems are stigmatized in the fire service, discouraging firefighters from talking about such mental health issues as depression and chemical dependency or seeking treatment for them (Gulliver et al., 2018). Gulliver et al. studied firefighter attitudes regarding behavioral health in their 2018 study. Firefighters identified stigmas associated with mental health in the fire service and indicated that firefighter culture served as a barrier to accessing mental health care within the fire service. Participants reported that they were most likely to seek support from their spouses or friends for behavioral health problems. Some were distrustful of services and providers within their departments, so many reported seeking professional help from outside sources. However, firefighters also indicated that they valued provider knowledge of firefighter culture, and that they found it difficult to find providers with that understanding. Studies like these may be of interest to leadership organizations in the fire service, like the IAFF and NFPA, who recognize behavioral health problems and the growing issue of firefighter suicide (NFPA, 2016; Wilmoth, 2014).

Sleep, Stress, and PTSD

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 (Krantz, Thorn, & Kiecolt-Glaser, 2017). According to the findings of a between-groups quantitative study of sleep deprivation, blood levels of the stress hormone cortisol seem to be influenced by sleep (Vargas & Lopez-Duran, 2017). Vargas and Lopez-Duran examined the effects of sleep deprivation on healthy participants and found a significant difference in cortisol levels between the control group, where members received adequate sleep, and the experimental group that was completely deprived of sleep overnight. After baseline cortisol samples were taken, participants were asked to complete the Trier Social Stress Task (TSST). The TSST is comprised of three parts, each with the aim of promoting various stress responses: 1. anticipatory stress- subjects are told they will give a presentation before an audience and are given a few minutes to prepare notes, 2. social stress- subjects' notes are taken away, they are told they must present for five minutes, and the audience remains expressionless during the five-minute presentation, giving the subject no feedback, and 3. evaluative stress- subjects are required to do a compounding, backwards arithmetic task in front of judges and must start over each time they make a mistake. After completing the TSST, cortisol levels were again measured. Significant differences in baseline and post-test measurements of cortisol levels were found between groups. Baseline cortisol levels were higher in the sleep-deprived group than in the control group. Further, sleep-deprived participants showed blunted levels of cortisol after completing the TSST, where the control group's cortisol levels increased in response to the stressful tasks. These findings indicate an altered stress response among the sleep-deprived and are worth giving further

consideration, particularly for firefighters who may be frequently sleep-deprived and working under stressful conditions.

The stress and pressure that firefighters experience in the line of duty can be extreme and life-threatening in nature. Their extraordinary, life-threatening experiences can contribute to the development of PTSD, which is common in the fire service (Henderson et al., 2016; Kehl, Knuth, Hulse, & Schmidt, 2014; Wagner, McFee, & Martin, 2010). Those suffering from PTSD often also suffer from sleep disturbances, with nightmares being a common symptom of the disorder. In a comparison study of veterans with PTSD, veterans with primary insomnia, and healthy controls, researchers found that veterans with PTSD had significantly poorer objective sleep efficiency than both veterans with primary insomnia and healthy controls (Straus et al., 2015). Veterans with PTSD also had less predictable sleep patterns. Based on their findings, Straus et al. (2015) highlight the importance of consideration for sleep therapy when working with individuals with PTSD, as the disorder often impacts one's sleep.

Conversely, it seems that poor sleep may also be predictive of PTSD. According to the findings of one 2013 study, National Guard troops who reported poor pre-deployment sleep were more likely to be diagnosed with PTSD and/or depression in post-deployment measurements than troops who had reported adequate pre-deployment sleep (Koffel, Polusny, Arbisi, & Erbes, 2013). These findings could be particularly relevant for firefighters, who in their roles as emergency workers are both an at-risk group for developing PTSD (Henderson et al., 2016), and more likely to experience chronic sleep deprivation than other professions. In this sense, interventions aimed at improving firefighter sleep could also serve as protective measures against the development of PTSD and its comorbid behavioral health problems, like substance abuse, depression, and suicide.

Sleep and Cardiovascular Health

Perhaps most obvious of all: sleep disturbances negatively affect physical health. Not only do all bodily systems rely on sleep for restoration and repair, many critical cognitive and metabolic functions take place during sleep (Walker, 2017). Firefighters work hard in a physically demanding job. They presumably understand the importance of getting enough exercise, staying hydrated, eating the right foods, and checking in with medical doctors regularly. However, based on the lack of research regarding firefighters and sleep, it is not clear that they understand the importance of getting enough, high-quality rest. Firefighters suffer from higher heart-related occupational mortality rates than any other occupation (Kay, Lund, Taylor & Herbold, 2001), with sudden cardiac arrest being the leading cause of firefighter line-of-duty death between the years 2001 and 2004 at an alarming 45% (Kales, Soteriades, Christophi, & Christiani, 2007). These statistics have decreased over time, as fire service leadership has begun to emphasize the importance of heart health (Fahy, LeBlanc, & Molis, 2016; NFPA, 2017), but nevertheless, cardiovascular disease persists within this population. While heart disease is understood to be a significant threat to fire fighters, the ways in which sleep disturbances may relate to heart disease in the fire service remain to be explored.

Sleep deprivation has been found to contribute to atherosclerosis, hypertension, and myocardial infarction (Tobaldini et al., 2017). A regional heart study of 7,735 men between the ages of 40 and 59 found that reports of short duration of nighttime sleep as well as daytime napping for greater than one hour (indicative of daytime sleepiness) were related to heart failure (Wannamethee et al., 2016). While the relationship between short nighttime sleep duration and heart failure was attenuated after controlling for such factors as smoking, hypertension, age, and prior history of cardiovascular disease, other studies have yielded similar findings. In their

systematic review of sleep deprivation and heart disease, Tobaldini et al. (2017) discovered that individuals suffering from sleep deprivation are at a higher risk for developing cardiovascular and metabolic diseases than those who get adequate sleep. These researchers found that the sleep-deprived were at a higher risk for developing such cardiovascular and metabolic issues as coronary artery disease, arrhythmia, hypertension, diabetes, and obesity. Tobaldini et al. (2017) stressed the importance of early detection of and treatment for sleep disorders as a protective measure against the development of cardiovascular disease. For a population that suffers from such staggering cardiac arrest rates, the implications of these findings are extremely relevant to firefighters from a prevention standpoint.

Conclusion

Firefighters can experience sleep deprivation at a higher rate than those in other occupations (Barros et al., 2012). To date, formal firefighter research studies have been mostly exploratory. Fire service leadership organizations have identified three major areas of concern for firefighter well-being: cardiovascular disease, mental health/suicide, and cancer (IAFF, 2017; NFPA, 2016). Sleep seems a topic worth further investigation as to how it may relate to all of these aspects of firefighter health and wellbeing (Chung et al., 2009; Kales et al., 2007; Tobaldini et al., 2017; Walker, 2017). Unfortunately, without a research base to draw from, an investigation into the significance of sleep deprivation in the fire service cannot be completed. Additionally, the firefighter population can be difficult to access because of a cultural distrust of outsiders and mental health stigmas (Gulliver et al., 2018). Is there a relationship between sleep deprivation and firefighter health, and if so, how might social workers use sleep to access these emergency workers?

Conceptual Framework

In his Hierarchy of Needs Theory, influential psychologist Abraham Maslow identifies sleep as an essential primary need, along with other physiological needs, such as: food, air, warmth, and water (Maslow, 2013). Maslow proposed that humans must satisfy their needs in a hierarchical order, tending to the most basic needs first, before they can progressively move on to higher-order needs, and finally, reach self-actualization (*see Figure 1*). Maslow's theory is supported in modern-day research regarding sleep, where sleep has been identified as influential in cognitive functioning, psychosocial well-being, health, quality of life, and longevity (Kamphuis et al., 2016; Martindale et al., 2017; O'leary et al., 2016; Quan, 2008; Tobaldini et al., 2017; Wannamethee et al., 2016; Walker, 2017; Watling et al., 2016).

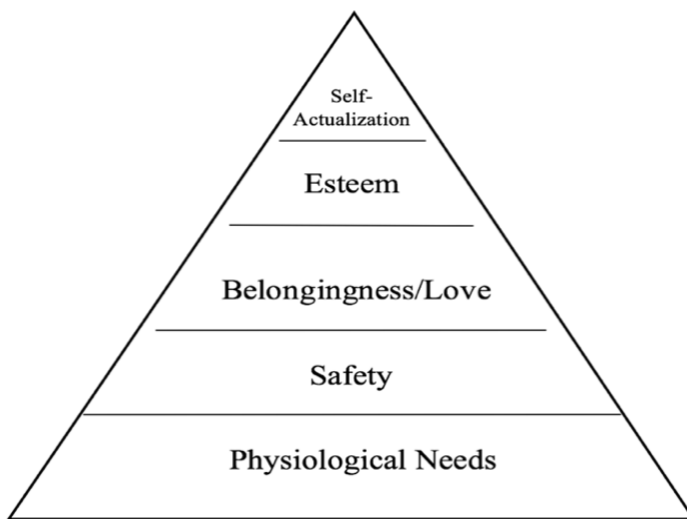


Figure 1. Maslow's Hierarchy of Needs

Level One: Physiological Needs

Sleep is a fundamental necessity for survival and so, it is housed in the primary level of Maslow's Hierarchy of Needs, along with food, water, air, and warmth. Every aspect of health and wellness can benefit from getting enough quality sleep every night, and yet, in Western

society sleep is undervalued and even stigmatized in some cases (Walker, 2017). Sleep is a basic need that should not be sacrificed any more than any of the other needs in level one of Maslow's hierarchy. Nevertheless, sleep is routinely compromised in a civilization that values productivity and drive. According to the World Health Organization, the National Institute of Health, and National Sleep Foundation, adults should be sleeping between 7 and 9 hours at night (USA Department of Health and Human Services, 2011). Ideally, falling asleep and waking would happen naturally with the setting and rising of the sun and sleep would take place in a slightly cool and private room, free from light, noise, and other distractions of the modern world (Walker, 2017). While satisfying all of the recommendations made by sleep doctors and educators is unrealistic for most, it is impossible for professional firefighters, whose conditions of sleep are greatly out of their control while on-duty.

Firefighters have inconsistent sleeping conditions while on-duty and the environments of each fire station are different. Some firefighters sleep in private rooms, while others share sleeping quarters with many people- increasing the odds of having their sleep disrupted throughout the night. Some stations may be equipped with temperature control systems, while others are not. Some are in bright, noisy downtown areas while others are in dark, quiet neighborhoods. Regardless of the environment they sleep in, all firefighters face a common sleep dilemma: their sleep is unpredictable. For firefighters, opportunities to sleep are at the mercy of the public's need for emergency services on any given night. When an alarm sounds, firefighters must quickly respond. They have to get out of bed, slide a pole, put on heavy equipment, and climb onto their trucks. Then, in a matter of just a couple minutes, firefighters' bodies must make the transition from restorative sleep to intense firefighting operations, like chopping a hole in roof, or carrying a person out of a burning building. The emergency

operations firefighters are required to carry out during the night can put a lot of stress on their bodies. Further, exposure to daytime stimuli (like light, noise, increased body temperature, and stress hormones) at night can lead to circadian misalignment, which has been found to contribute to a wide variety of health problems (Yong et al., 2016).

Higher-Order Needs

Maslow identified safety needs as the second most important human needs, after physiological ones. It is clear from existing research that not only is there a profound problem with sleep disturbances among firefighters, but also that these problems may impact their safety needs (Barros, et al., 2012; Kales et al., 2007). Studies focused on sleep deprivation and its resulting cognitive deficits (Aran et al., 2016; Kamphuis et al., 2016; Martindale et al., 2017) are of interest regarding firefighter safety. Firefighters' safety depends on their abilities to think and act without delay, often under stressful and dangerous conditions. Per the findings of the aforementioned studies, sleep deprivation can negatively impact cognitive functioning and impair judgment, compromising firefighter safety. This could have serious implications for both firefighters and civilians involved in life-threatening emergencies; both parties relying on firefighters' abilities to make fast and appropriate decisions to keep them safe.

Provided that physiological and safety needs have been met, Maslow proposes that one must next form social connections to satisfy the need for belongingness and love. The O'leary et al. (2016) study produced findings relevant to firefighter relationships. The study highlighted the ways that sleep disturbances negatively influence perception and mood, factors that are influential in interpersonal functioning and relationship-building. The results of the O'Leary et al. (2016) and Watling et al. (2016) studies illustrate a relationship between poor sleep and negativity in affect and perception. Negative affect and attitudes could erode the personal

relationships of firefighters over time. This may be especially true for female firefighters, who have been found to divorce at a higher rate than their male counterparts within the fire service, as well as when compared with females in the general population (Haddock et al., 2016). Failure to connect with others and/or disruption to loving relationships can leave people feeling sad and alone; something that Maslow proposes will keep them from moving on to the next level of need: the need for self-esteem.

In recent years, various firefighter leadership organizations have begun to acknowledge a mental health crisis facing the fire service: firefighter suicide. In a November of 2016 briefing (NFPA, 2016), the NFPA identified suicide, depression, and substance use as components of a behavioral health crisis facing the fire service, and stressed the importance of taking both preventative and responsive actions. The IAFF is also working on bringing awareness to the behavioral health needs of firefighters, with health initiatives aimed at decreasing the stigma associated with mental health, providing chemical dependency treatment facilities, and promoting firefighter peer support programs to combat firefighter suicide (IAFF, 2017). While the efforts being made by these fire service organizations are certainly positive, there may be other proactive measures that can be taken as well. Providing firefighters with sleep hygiene education to augment mental health initiatives could be a simple and effective strategy, as research supports that poor sleep, depression, and suicidality share positive relationships (Stubbs et al., 2016).

Maslow's theory proposed that few reach self-actualization, or achieve a sense of purpose, identity, and contentment. While it is impossible to know whether firefighters are more or less self-actualized than others, it is worth consideration that the sleep disturbances they experience in Maslow's primary level may serve as barriers to the population achieving self-

actualization. Firefighters provide a necessary public service, dedicating their lives to the safety of others. They put themselves in harm's way and sacrifice a lot for the communities they serve. Without adequate research on the firefighter population there is no way to be certain how their disturbed sleep relates to their health, and firefighters are an underrepresented population in today's research literature. An exploratory research study of firefighter sleep deprivation could set a foundation for other studies to build upon, and identify barriers to accessing the exclusive population.

Methodology

Procedure

As there are notable differences between the sleep and work schedules of full-time, professional firefighters and volunteer/paid-on-call firefighters, this study was limited to exploration within professional fire departments, where firefighters work overnight shifts. Permission to conduct the study was granted by the Institutional Review Board at the University of Saint Thomas. Recruitment invitations containing informed consent (*see Appendix B*) and an anonymous link to the survey were sent to all full-time firefighters in the suppression branches of each fire department via departmental email systems, with permission and assistance from department heads. To further ensure that all participants met the study's eligibility requirements, the survey began with the following forced-answer, True/False statement: "I am a professional firefighter, assigned to the suppression branch of a full-time fire department. I can read/understand English and am 18 years of age or older." Participants choosing, "False" in response to this statement were immediately routed to the end of the survey and excluded from the study. Participants choosing, "True" in response to this statement were considered eligible and routed to the beginning of the survey. Qualifying participants were given a 26-question

survey regarding health, with a focus on sleep (*see Appendix A*). Online survey administration was conducted through Qualtrics software (Qualtrics, Version 2018, Provo, UT, 2018) and statistical analysis was performed using IBM's Statistical Package for the Social Sciences (SPSS) analytic software (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY, 2013). The survey opened February 1st and closed March 18th of 2018. Partial-response surveys that did not contain answers to four key health and sleep-related questions (questions 10, 11, 14, and 15) were excluded from the data set.

Sample

To meet inclusion requirements, all participants were eighteen years of age or older, literate in the English language, and employed full-time as firefighters in the suppression branches of professional fire departments in the Midwest. Participating fire departments ensured survey dissemination to eligible participants via inter-departmental email. A total of 275 professional firefighters elected to participate and as a group, were mostly homogeneous. Of the 269 participants who chose to identify their genders, 259 identified as male, 10 as female, and zero as transgender: 96.28% male (N = 259) and 3.72% female (N = 10). The 268 participants who elected to identify their race varied little in terms of racial identity; 92.91% identified as Caucasian (N = 249), 4.1% as biracial or poly-racial (N = 11), 1.87% as African-American (N = 5), 0.75% as American Indian or Alaskan Native (N = 2), and 0.37% as Asian or Pacific Islander (N = 1). Of the 268 participants who identified their race, 3.36% reported being of Hispanic descent (N = 9). While the 275 participants that made up the sample were not representative of the general population in terms of gender or race, the sample was representative of the United States Fire Service (Fox, Hornick, & Hardin, 2006), which is disproportionately comprised of Caucasian males who are of non-Hispanic descent. The mean age of participants was 42.56 with

a range of 21-63 years and a standard deviation of 8.56 years. The 271 participants who reported their company assignments illustrated that the firefighters in this sample were responsible for a wide variety of firefighting operations: 91 (33.1%) reporting their most typical assignment to an Engine Company, 40 (14.5%) to a Ladder Company, 41 (14.9%) to firefighter swing crews, 25 (9.1%) to Specialty Rescue operations (such as Heavy Rescue or Hazmat), 16 (5.8%) to Command and Support staff positions, 10 (3.6%) to medical units, and 47 (17.1%) indicated that they were assigned to firefighter/medic swing company operations. There was also variation among participants in their reported years of enlistment in the fire service. Of the 271 participants who indicated their years of service, 12.7% reported that they had served less than 5 years (N = 35), 15.6% reported serving 6-10 years (N = 43), 24.7% reported serving 11-15 years (N = 68), 20.4% reported 16-20 years of service (N = 56), and 25.1% reported that they had been fighting fires for 21 years or more (N = 69).

Measures

A 26-question survey (*see Appendix A*) was administered online to qualifying participants. Demographic information was collected, including: age, gender, veteran status, race, and ethnicity. Job-related demographics were also surveyed and included the number of hours a participant works during each shift, their years of service as a firefighter, and the company operations to which they are most typically assigned. Participants were asked a series of health-related questions, with a focus on sleep. Included in the survey were three sleep measurements. The first was the standardized Epworth Sleepiness Scale (ESS), a self-report measurement of excessive daytime sleepiness. Second was a quantitative, self-report estimate of average nighttime sleep (both on-duty and off-duty), as measured in hours. Third, a measurement of sleep onset latency (SOL) was taken in minutes to identify participants that were

excessively sleepy due to accrued sleep debt (Dement & Vaughn, 1999). Participants were also asked to report any professional diagnoses of sleep disorders (Insomnia, Sleep Apnea, or Other) since becoming a firefighter. Further, where an affirmative response was indicated for a professional diagnosis of Sleep Apnea, participants were questioned regarding their adherence to medically prescribed protocol (use of Continuous Positive Airway Pressure, or CPAP) in relation to the diagnosis. Diagnosis of a sleep disorder, as well as measurements of the ESS, sleep quantity, and/or a short SOL were considered indicative of daytime sleepiness related to sleep deprivation and/or the accumulation of sleep debt over time (Chervin, Aldrich, Pickett, & Christian, 1997; Dement & Vaughn, 1999; Kenderska et al., 2014).

The Epworth Sleepiness Scale. The Epworth Sleepiness Scale is a standardized test that measures a participant's average daytime sleepiness (Chervin et al., 1997; Kenderska et al., 2014). It was used to identify individuals suffering from excessive daytime sleepiness. This scale takes into consideration that some situations, such as lying down for a nap, are more likely to cause drowsiness than others, such as talking with a friend. This 8-question assessment takes self-reported ratings of a participant's likelihood of falling asleep in various contexts. Participants rate themselves on a 4-point Likert scale (0-3) on the "likelihood of dozing" for each situation (*0 = would never doze, to 3 = high chance of dozing*). Scores for each of the eight items of the ESS are then added up and yield a total score that ranges from 0 to 24. The higher a participant's score on the ESS, the sleepier he or she is determined to be. In addition to receiving a raw ESS score, firefighters were assigned to an ESS group. Participants who scored a ten or below on the ESS were identified as having a normal amount of daytime sleepiness (NDS). Those who received a score of 11 or 12 were identified as having a mild case of excessive daytime sleepiness (MEDS). Those scoring 13-15 were identified as having a moderate case of

excessive daytime sleepiness (Mod-EDS). Finally, those who scored a 16 or higher were identified as having a severe case of excessive daytime sleepiness (SEDS).

Measurement of sleep quantity. Sleep quantity was measured both on-duty and off-duty. Measurements were taken via a multiple-choice question where participants were asked to estimate, on average, how many full hours of sleep they achieve while on-duty and off-duty. Participants chose between four options: (a) 0-2 hours, (b) 3-4 hours, (c) 5-6 hours, and (d) 7 or more hours. Based on the recommendations of the World Health Organization and National Sleep Foundation (Hirshkowitz, et al., 2015), the following identifiers were used for each group: (a) 0-2 hours: Severely Sleep Deprived (SSD), (b) 3-4 hours: Moderately Sleep Deprived (Mod-SD), (c) 5-6 hours: Mildly Sleep Deprived (MSD), and (d) 7 or more hours: Met Minimum Recommendation (MMR).

Measurement of Sleep Onset Latency. In order to measure sleep onset latency (SOL), participants were asked the question, “Once you lie down, how long does it typically take for you to fall asleep?” Participants chose from three options: (1) Less than five minutes, (2) more than five minutes, but less than thirty minutes, and (3) thirty minutes or more. Participants who indicated that they fall asleep in less than five minutes were identified as excessively sleepy, based on the findings of William Dement and his colleagues in their study of sleep latency as it relates to sleepiness (Dement & Vaughn, 1999). Two groups were identified: those who were excessively sleepy and those who were not.

Sleep onset latency, sleep quantity grouping (MMR, MSD, Mod-SD, SSD), sleep environment, ESS score (0-24), ESS group (NDS, MEDS, Mod-EDS, SEDS), and reported use of various sleep and wakefulness aids were designated “sleep-related variables” for purposes of analyses. In addition to sleep-related questions, participants were asked questions about various

aspects of their health and well-being, including questions about their cardiovascular, metabolic, mental, emotional, and behavioral health. Answers to these questions were designated “health-related variables.” With a “yes” or “no” answer, participants were asked to indicate whether they had been professionally diagnosed with a health issue since becoming a firefighter (i.e. cardiovascular disease, obesity, or Sleep Apnea). Participants were then divided into two groups on health-related variables: those with a professional diagnosis and those without. Participants were also asked to assess their own health and wellness needs, and to indicate their use of and interest in various health and wellness resources. Answers to these questions were designated “wellness-related variables” and were similarly coded into two nominal groups.

Analyses

All survey questions were converted into variables and coded in SPSS. The ESS score (0-24) and participant’s age were coded at the interval-ratio level, while ESS group (NDS, MEDS, Mod-EDS, SEDS), on/off-duty sleep quantity measurements, shift hours, and years of service were coded as ordinal. Participants’ SOL, demographic information, and all health-related and wellness-related variables were coded at the nominal level. As an exploratory study, much of the analyses conducted were descriptive in nature. Frequency distributions were configured for all variables to identify potential disparities in the sample. The total sample (N = 275) was found to be homogeneous in terms of gender (male), race (Caucasian), ethnicity (non-Hispanic descent), and hours worked per shift (12-24 hours), so these variables were not further analyzed. Similarly, small sample sizes in some variables either eliminated them from further analysis (i.e. SUD diagnosis and Treatment for SUD), or resulted in their recoding. Recoded variables included individual sleep disorders (Sleep Apnea, Insomnia, Shift Work Disorder, and Restless Leg Syndrome) and mental health diagnoses (Depression, Anxiety, PTSD), which were

instead grouped together and coded as the nominal variables “mental health diagnosis” and “sleep disorder diagnosis.”

Chi-squares (χ^2) were used to identify relationships between variables at the nominal and/or ordinal levels. Sleep-related variables, including ESS group (NDS, MEDS, Mod-EDS, and SEDS), reported on-duty sleep quantity (MMR, MSD, Mod-SD, SDS), and SOL were analyzed against various health measurements, categorical company assignments, and years of service. Independent sample *t*-Tests were used to analyze group differences within variables. Multivariate analyses of variance (ANOVA) were used to examine differences between participants in relation to sleep, health, and wellness-related variables, based on ESS scores (ranging from 0-24) and age. All analyses were conducted using $\alpha = .05$ as criterion for significance.

Results

Firefighters and Sleep

The survey results indicate that at an astounding 98.5%, the vast majority of firefighters are not meeting the minimum recommendation for sleep while on-duty. Based on reported sleep quantity in full hours, the largest grouping of firefighters (48.9%, $n = 133$) was found to be moderately sleep deprived (Mod-SD), reporting an average of 3-4 hours of on-duty sleep. The next largest group was identified as mildly sleep deprived (MSD), with 43.38% ($n = 11$) reporting an average of 5-6 hours of on-duty sleep. Even the most severely sleep deprived (SSD) firefighters outnumbered the adequately rested at 6.25% ($n = 17$). In a substantial minority, only 1.5% of firefighters ($n = 4$) reportedly met the minimum recommendation (MMR) of 7 hours of sleep while on-duty. Interestingly, firefighters' off-duty sleep reports produce very different results (*see Figure 2*), with the majority of firefighters (57.4%, $n = 156$) reporting adequate off-

duty sleep. Similarly, the environments in which firefighters are sleeping seem to vary between their on-duty and off-duty lives. While 94.9% ($n = 258$) of firefighters reported sleeping in a private room while off-duty, only 44.9% ($n = 122$) reported the same while on-duty. The remainder indicated that they either slept in a shared space or had inconsistent sleeping environments from day to day.

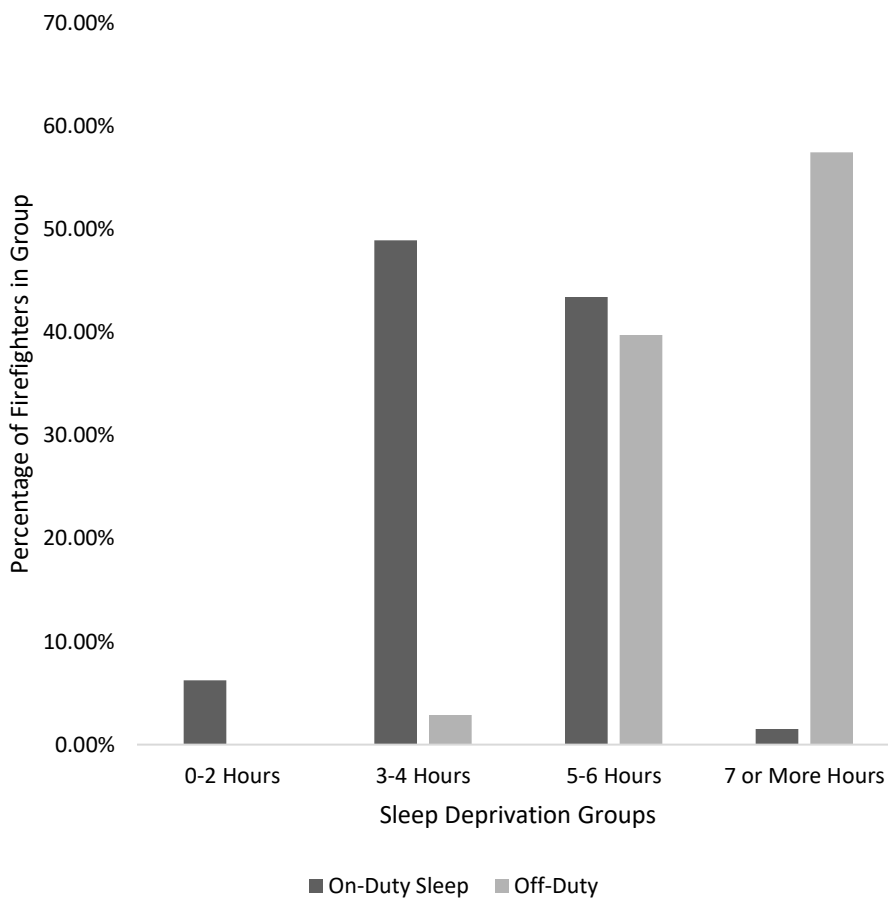


Figure 2. Hours of sleep reported while on duty vs. hours of sleep reported while off-duty

The findings of the survey also indicate that many firefighters suffer from some degree of excessive daytime sleepiness due to accumulated sleep debt, as measured by having a sleep onset

latency (SOL) of less than five minutes. Of the firefighters surveyed, 29.0% ($n = 79$) reported such an SOL. In addition to the near third of firefighters whose SOL scores indicate their excessive sleepiness, the ESS scores of nearly half illustrate the same (see Figure 3). Of the 272 firefighters who completed the Epworth Sleepiness Scale, 42.9% ($n = 118$) scored an 11 or above. Among the excessively sleepy firefighters, 14.2% ($n = 39$) scored in the MEDS range, 14.9% ($n = 41$) in the Mod-EDS range, and 12.7% ($n = 35$) in the SEDS range. Further evidence of daytime sleepiness may be reflected in the data collected regarding the use of sleep and wakefulness aids by firefighters. While many firefighters indicated that they did not use any type of sleep aid (30.75%, $n = 123$), most reported using at least one type of wakefulness aid, with caffeine being the most common (79.27%, $n = 218$). Of the sleep aids that firefighters reported using, the most common were alcohol (31.64%, $n = 87$) and herbal supplements, such as melatonin (23.64%, $n = 65$).

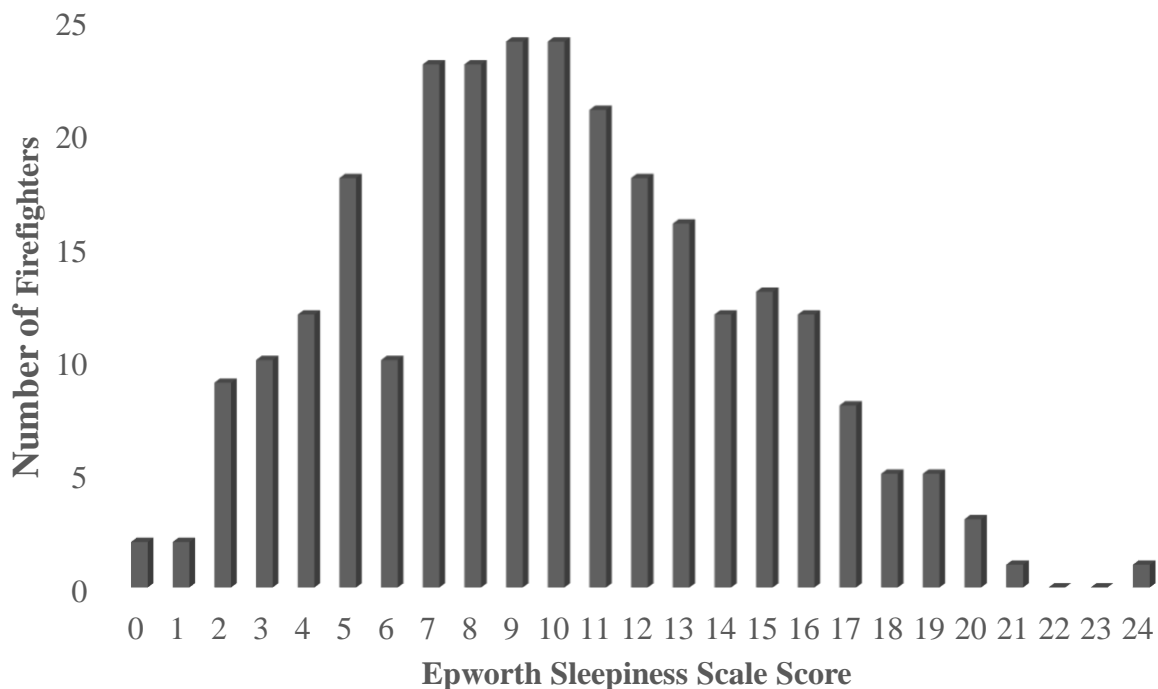


Figure 3. Distribution of firefighter ESS scores

In addition to examining the subjective experiences of chronically sleep-deprived firefighters, this study also collected data regarding professional sleep disorder diagnoses. Since becoming firefighters, 8.5% ($n = 23$) indicated that they have been professionally diagnosed with Sleep Apnea, 3% ($n = 8$) with Insomnia, and 4.1% ($n = 11$) selected “Other” and reported diagnoses of Shift Work Sleep Disorder or Restless Leg Syndrome. Of those with Sleep Apnea, only half (52.2%, $n = 12$) indicated that they sleep wearing their prescribed CPAP machines while both on-duty and off-duty. Six firefighters (26.1%, $n = 6$) with Sleep Apnea reported using their CPAP as directed when off-duty only, and 21.7% ($n = 5$) admitted to not using their CPAP machines as prescribed by their doctors, regardless of the conditions.

Firefighter Health and Wellness

Nearly one in five participants ($n = 50$, 18.5%) reported that they have been professionally diagnosed with cardiovascular disease since becoming a firefighter. Of those who indicated they had been diagnosed with cardiovascular disease, 71.4% ($n = 35$) reported a diagnosis of hypertension, 16.3% ($n = 8$) an atherosclerosis diagnosis, 26.5% ($n = 13$) arrhythmia, and 4.1% ($n = 2$) reported having suffered a myocardial infarction since becoming a firefighter. The second biggest health problem firefighters reported was obesity, with 18.1% ($n = 49$) reporting having been professionally diagnosed as obese since becoming a firefighter. Similar results were found regarding firefighter mental health, with 17.1% ($n = 46$) of participants affirming that they had received a professional diagnosis since joining the fire service: depression ($n = 27$), anxiety ($n = 18$), and/or PTSD (19). Ten firefighters (3.7%) had received professional diagnoses of Substance Use Disorder (SUD), 70% ($n = 7$) of whom indicated that they had received treatment and/or worked a formal recovery program. Of the 272

participants who elected to answer question 18 (*see Appendix A*), 38 (13.8%) indicated that they, or someone close to them, was concerned the firefighter had a drinking or drug problem, 10 (3.6%) weren't sure if there was a problem, 3 preferred not to answer the question, and 221 (80.4%) were not concerned of a problem with substance use.

Participants were asked to identify which aspects of their health and wellness were most in need of attention and improvement (*see Table 1*), as well as to indicate their interest in using various health and wellness resources (*see Table 2*). Findings were not completely congruent between the aspects of health that firefighters identified as needing attention/improvement and the resources that they were interested in utilizing. For example, more firefighters (67%; $n = 175$) identified sleep as needing improvement than any other aspect of their health and wellness, yet utilization of sleep health resources did not receive the greatest interest of the group (55.5%; $n = 113$). Instead, the most firefighters expressed interest in physical fitness resources over the other choices (65.1%, $n = 179$). This is regardless of the fact that participants were not asked to rank or limit their selections on these measures, but rather were allowed to choose as many items from the resource list as they were interested in. Similarly, the findings revealed a recognized need among firefighters to improve their intimate relationships (26.4%, $n = 69$) and social lives (22.2%, $n = 58$), with fewer reporting interest in accessing professional services, such as marriage and family therapy (23.6%, $n = 60$) or peer support programs (17.7%, $n = 45$), to address these needs.

Table 1.
Aspects of Health and Wellness that Firefighters Feel Need Attention/Improvement

Needs Attention/Improvement	Identified Need (n)	Identified need (%)
Sleep	175	67.0
Physical Fitness	135	49.1
Physical Health	102	39.1
Mental Health	78	29.9
Intimate Relationships	69	26.4
Socialization	58	22.2
Finances	52	19.9
Religion/Spirituality	43	16.5
Parenting/Child Care	43	16.5
Self-Esteem	34	13.0
Addiction	16	6.1
Legal Issues	4	1.5
Safety/Security	2	0.8

Table 2.
Health and Wellness Resources Firefighters Are Interested in Using

Resource	Interested Firefighters (n)	Interested Firefighters (%)
Physical Fitness	179	70.5
Medical Doctors/Specialists	139	54.7
Sleep Hygiene and Education	113	44.5
Integrative Care	111	43.7
Psychiatric Clinicians	80	31.5
Financial	80	31.5
Marriage/Family Therapy	60	23.6
Self-Help	60	23.6
Religion/Spirituality	59	23.2
Employee Assistance	49	19.3
Firefighter Peer Support	45	17.7
Legal Services	34	13.4
Parenting/Child Care	32	12.6
Addiction	11	4.3

Firefighting, sleep, health, and wellness

Chi-square (χ^2) analyses found significant relationships between some sleep, health, and wellness-related variables. Epworth Sleepiness Scale groups (NDS, MEDS, Mod-EDS, SEDS)

were compared in terms of cardiovascular disease and a significant relationship was found between a firefighter's ESS group and the existence of a professional diagnosis of cardiovascular disease: $\chi^2(3, N = 271) = 10.51, p = .015$. Similarly, significant relationships were found between a firefighter's ESS score group and the existence of a professional diagnosis of obesity $\chi^2(3, N = 271) = 10.02, p = .018$, as well as between diagnoses of cardiovascular disease and obesity $\chi^2(1, N = 270) = 6.26, p = .012$. No relationships were found between a firefighter's ESS score group and mental health diagnoses: $\chi^2(3, N = 269) = 4.10, p = .250$. Neither was there a relationship found between firefighters' reported use of alcohol as a sleep aid and their ESS score group: $\chi^2(9, N = 272) = 14.57, p = .104$. Chi-square (χ^2) analyses were also conducted comparing years of service as a firefighter on the aforementioned health measures, finding weak relationships between years of service and both cardiovascular disease $\chi^2(4, N = 270) = 31.11, p = .000$, and obesity $\chi^2(4, N = 270) = 14.44, p = .006$. However, a participant's reported years of service as a firefighter were found to be unrelated to him/her having received a mental health diagnosis $\chi^2(4, N = 268) = 5.40, p = .248$ or using alcohol as a sleep aid $\chi^2(4, N = 267) = 4.76, p = .313$. Finally, a significant relationship was found between the type of company operations to which a firefighter was assigned, and the existence of cardiovascular disease $\chi^2(6, N = 269) = 23.59, p = .001$. Engine companies (26.5%, $n = 13$) and Ladder companies (18.4%, $n = 9$) had the most firefighters with cardiovascular disease (*see Figure 4*), but because of disparate sample sizes between firefighting groups, a within-group analysis of cardiovascular disease as it relates to company assignments was also completed. These data indicated that within company assignments, more firefighters assigned to Medic Units (70%, $n = 7$) and Command/Support positions (31.3%, $n = 5$) have been diagnosed with cardiovascular disease when compared to those assigned to other company operations (*see*

Figure 5). Company assignment was found to be unrelated to an obesity diagnosis $\chi^2(6, N = 269) = 8.22, p = .222$, or reported use of alcohol as a sleep aid $\chi^2(6, N = 266) = 8.78, p = .186$.

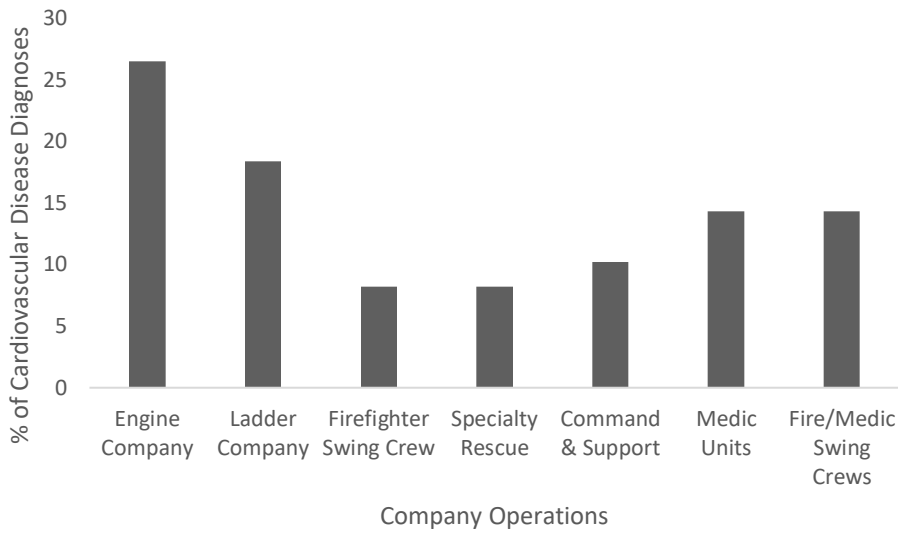


Figure 4. Distribution of firefighters with cardiovascular disease by company operations to which they are assigned

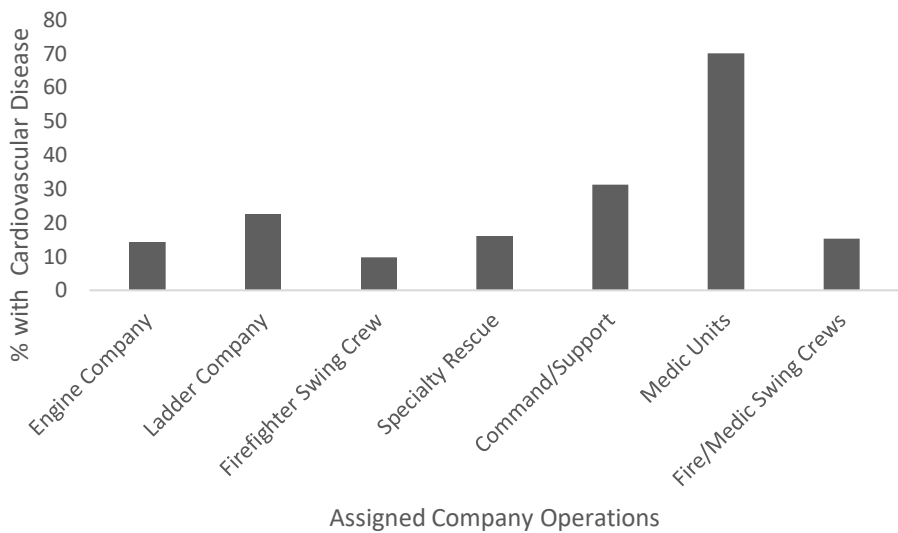


Figure 5. Percentage of firefighters within company assignment who have been diagnosed with cardiovascular disease

Independent Sample *t*-tests were conducted to identify group differences in ESS scores (0-24) between those with a professional diagnosis and those without. In terms of ESS score, no significant group differences were found between those with cardiovascular disease and those without $t(271) = .073$, those with a mental health diagnosis and those without $t(269) = 62.45$, or those diagnosed with a Substance Use Disorder and those without $t(272) = 270$. However, there were group differences on measurement of ESS score between those with an obesity diagnosis and those without $t(271) = .007$, with the mean ESS score of obese participants ($M = 11.47$) being almost two points higher than that of participants who were not obese ($M = 9.51$). An independent sample *t*-Test between participants who reported using alcohol as a sleep aid and those who did not also revealed group differences in ESS score $t(268) = .05$, where the mean ESS scores of those participants who reported using alcohol ($M = 10.69$) were 1.18 points higher than those who indicated that they do not use alcohol to help them sleep ($M = 9.51$). Interestingly, there were no group differences in ESS score between those with a professional sleep disorder diagnosis and those without [Sleep Apnea $t(272) = 270$; Insomnia $t(271) = 269$]. Further, there were no significant group differences on any measure between veterans and non-veterans.

No significant group differences based on ESS raw score were found on any of the measures, however, there were group differences in age on more than one measurement, including ESS score grouping. An ANOVA of age between ESS groups found significant group differences ($p = .002$) in mean age, with older participants being more likely to be assigned to the more sleep-deprived Mod-EDS ($M = 45.95$) and SEDS ($M = 45.53$) groups than the MEDS ($M = 41.95$) and NDS groups ($M = 41.17$). Significant differences in age were also found between

groups based on cardiovascular disease ($p = .000$) and obesity ($p = .002$). Participants who had been diagnosed with cardiovascular disease were found to be 6.99 years older on average ($M = 48.29$) than those without a cardiovascular disease diagnosis ($M = 41.30$), and those who had been diagnosed as obese ($M = 45.06$) were an average of 3.1 years older than those who were not obese ($M = 41.96$).

Discussion

The findings of this exploratory study indicate that firefighters are not getting enough sleep while on-duty, and that many of them are excessively sleepy throughout the day. Further, it seems that excessive daytime sleepiness due to the accumulation of sleep debt over time is related to cardiovascular disease and obesity among firefighters. This was found to be particularly true as the firefighters' years of service increase. It is noteworthy that the relationships between firefighters' years of service and health diagnoses could also be explained simply by aging, so future studies should compare the cardiovascular, metabolic, and sleep health of firefighters with measurements from those of cohorts in the general population. It is also worth noting that subsample sizes were disparate in several of the between-groups analyses: in the most extreme case, there being a difference of 255 people in group sizes (8 with Insomnia: 263 without). Vast differences in group sample sizes may have impacted findings and should therefore be taken into consideration. Finally, it is important to consider that firefighters' livelihoods depend on their physical fitness, and that the survey given to them contained sensitive, health and fitness-related questions. Further, the dissemination of the survey to the firefighters relied on the assistance of their department heads (Fire Chiefs). Despite the fact that the participants were given informed consent (*see Appendix B*) and assured of their anonymity in completing the survey, it is possible that some were hesitant to truthfully disclose sensitive

health information within it. Future research within this population should consider whether an alternative means of accessing the firefighter population would alleviate potential concerns, and encourage greater participation.

Sleep and Health

With sudden cardiac arrest being the leading cause of firefighter line-of-duty death, it is no wonder that organizations like the NFPA and IAFF are recognizing the need to address cardiovascular disease in the fire service. It is of interest then, to examine the ways that firefighters can improve their cardiovascular health by improving their sleep. As the literature has shown, sleep deprivation can contribute to a myriad of health problems, including: such cardiovascular diseases as hypertension and atherosclerosis, and metabolic diseases like diabetes and obesity. In support of findings in the literature, the current study identified significant relationships between sleep debt (as measured by ESS score grouping) and both cardiovascular disease and obesity. Further, obesity and cardiovascular disease were found to be related to one another. A 2005 study of cardiovascular disease and obesity among firefighters identified obesity as a significant risk factor for the development of cardiovascular disease among firefighters (Soteriades et al., 2005). Soteriades et al. (2005) found that not only were obese firefighters more likely to suffer from cardiovascular disease than firefighters with healthy weights, but they were also more likely to develop cardiovascular disease, as was evidenced by one-year and five-year follow-up assessments. Further, the researchers found that obese firefighters gained weight at higher rates (1.9 lbs. vs 1.1 lbs. annually) than did their healthy-weighted counterparts. The current study revealed that almost one in five (18.1%, $n = 49$) of the sample reported an obesity diagnosis, and that nearly half (49.1%, $n = 135$) of the firefighters felt they needed to make improvements to their physical fitness. These findings justify further

exploration into the ways in which sleep deprivation, cardiovascular disease, and obesity relate to one another.

Firefighter Culture

Some of the findings in this study were incongruent, including: firefighters' recognition of the need for improved sleep vs. their interest in utilizing sleep resources, the high value firefighters place on physical health and fitness vs. their adherence to medical advice, firefighters' reported use of alcohol vs. reported diagnoses of SUD, and finally, the firefighters' desire for improved relationships vs. their interest in relational resources, like marriage and family therapy. These contradictory findings may be indicative of strong firefighter biases towards physiological health services over psychological ones, firefighter culture that serves as a barrier to accessing behavioral health services, and pervasive mental health stigmas within the fire service.

Many of the firefighters who participated in this study identified a need to improve their sleep. In fact, firefighters indicated that sleep needed the most attention and improvement, more than any other aspect of their health and well-being. It is surprising then, that when participants were asked to indicate which of several health and wellness resources interested them (*see Table 2*), they did not express the most interest in sleep hygiene and education resources. Rather, they showed the most interest in physical fitness resources, like gym memberships and medical doctors, above all else. Perhaps the firefighters simply do not believe that they would benefit from professional sleep assessments and training. Or, it may be that firefighters share, with the rest of Western society, a general underappreciation for sleep. Whatever the reason for the incongruence between firefighters' recognition of the need for improved sleep and expressed interest in sleep resources, firefighters could undoubtedly benefit from education about the

importance of sleep. Fire departments should give consideration to the implementation of sleep education training for all members, with an emphasis on the physiological benefits of sleep hygiene, as firefighter culture seems to highly value physical fitness. Further, departments should consider having medical doctors develop and present curriculum, as they were the health professionals whom firefighters indicated they would utilize most.

Although many firefighters expressed value in maintaining their physical health and interest in the utilization of medical resources, it is unclear to what extent firefighters are willing and/or able to follow medical direction while on-duty. Almost half (47.8%, $n = 11$) of the 23 firefighters who reported a diagnosis of Sleep Apnea indicated that they do not use their prescribed CPAP machines while on-duty. Failure to use a CPAP as medically directed can have very detrimental effects. Not only does Sleep Apnea compromise the quality and quantity of sleep that one is able to achieve, it also poses risks to his/her health and safety (“Sleep Apnea,” 2018). Firefighters with untreated Sleep Apnea are at a higher risk of developing cardiovascular disease, such as hypertension and congestive heart failure, than those without. Furthermore, for those with underlying heart disease, untreated Sleep Apnea is more likely to have grave consequences, like stroke and sudden cardiac arrest. With sudden cardiac arrest being the leading cause of firefighter line-of-duty deaths, and those suffering from Sleep Apnea being at a higher risk of it, all measures should be taken to support the use of CPAP machines among firefighters with Sleep Apnea. Future research should be aimed at identifying barriers to firefighters’ abilities to follow medical directions and observe sleep hygiene in fire stations.

Another disparity was found between firefighters’ reported use of alcohol as sleep aid ($n = 87$), expressed concern of the firefighter having a drug or alcohol problem ($n = 38$), and reported SUD diagnoses ($n = 10$). With so many more firefighters reporting use of alcohol as a

sleep aid than reported SUD diagnoses, it raises concern that there may be a substance use problem in the fire service that is going unnoticed and/or untreated. It is, of course, possible that none of the 87 firefighters who reported using alcohol as a sleep aid has a problem with alcoholism. Nevertheless, these data are deserving of further examination. Perhaps firefighter drinking culture is obstructive to the recognition of drug and alcohol problems in that it normalizes alcohol use and discourages seeking treatment for problems with chemical dependency. In a 2012 study of alcohol use among U. S. firefighters, researchers found that of the 459 career firefighters they interviewed, 85% confirmed regular alcohol use (Haddock et al., 2012). These firefighters reported drinking an average of 10 days a month: half of their approximately 20 off-duty days. Of the firefighters who reportedly drank alcohol, 56% endorsed binge-drinking at least once within the previous month and 53% admitted to drinking three or more drinks each time they drank. Findings in the current study indicated that even when alcohol and drug problems were identified, they weren't always treated. Of the ten firefighters who had been professionally diagnosed with SUD, only seven reported that they had sought professional treatment and/or worked a formal recovery program. Further studies should examine firefighters' attitudes towards substance use to identify possible barriers to the identification and treatment of drug and alcohol problems in the fire service.

In addition to normalizing substance use, firefighter culture stigmatizes mental health problems (Gulliver et al., 2018), discouraging firefighters from seeking help for them: sometimes until it's too late (Henderson et al., 2016). In their 2016 study of firefighter suicide, Henderson et al. found suicidality to be prevalent in the fire service and discovered that firefighters are much less likely than workers from other professions to seek treatment for their mental health, or talk about their problems with other firefighters. The current study identified that 17.1% ($n = 46$)

of the firefighters have received a professional mental health diagnosis, with depression being the most common. These findings may be under-representative of the actual prevalence of mental illness in the fire service, as they are smaller than those of the general population (Ahrsbrak et al., 2017). Delays in recognizing mental health and substance abuse problems, paired with firefighters' reluctance to seek help for them, are likely contributing to an epidemic of untreated firefighter depression and suicide. Further research should be conducted regarding firefighter attitudes and beliefs surrounding mental health to identify barriers to treatment.

Mental health stigmas may explain another incongruence in the results of this study. Findings indicate that fewer firefighters expressed interest in utilizing professional services to improve their relationships than identified a desire for better social connections and intimacy (*see Table 2*). As is the case with all aspects of health and wellness, firefighter relationships could be improved with better sleep. As was evidenced in the literature (O'Leary et al., 2016; Walker, 2017; Watling et al., 2016), chronic sleep deprivation could be negatively impacting firefighters' perceptions of the world around them, affecting their moods and emotional wellbeing, and worsening symptoms of existing depression- the most commonly reported mental illness in this study. Improvements in sleep could greatly impact the psychosocial wellbeing of firefighters and subsequently, their relationships with their friends and families.

Recommendations

The findings of this study indicate that firefighters are aware of a need to improve their sleep and are interested in the provision of sleep resources. This is good news. With sleep health trending and established firefighter buy-in, positive changes are more likely to take place. Sleep hygiene education should be provided to all firefighters. It could influence them to make better choices related to their sleep, which would subsequently impact other areas of their health

and wellbeing. Firefighters value physical health and fitness. It is likely that knowledge of the far-reaching health benefits of improved sleep would encourage them to value it more.

Furthermore, as a physiological need, sleep carries with it no stigma in the fire service. Sleep could therefore be used as a proxy for addressing more sensitive issues, like mental health and substance use among firefighters. Social workers and other mental health professionals should consider using sleep health to breach more sensitive topics with firefighters and should be knowledgeable about firefighter culture when working with this population.

A lot can be done to improve sleep. This includes making adjustments to one's schedule, diet, environment, and behaviors (Dement & Vaughn, 199; Walker, 2017). Firefighters can start to improve their overall sleep health by making every effort to improve their sleep while off-duty, where they have greater control over their sleep conditions. Those using alcohol as a sleep aid should be educated about its counter-productive effects. The current study supports previous research that alcohol degrades and disrupts sleep. Group differences in mean ESS scores were found between firefighters who reported using alcohol as a sleep aid and those who did not, with the mean ESS score of alcohol consumers being more than a point higher than the scores of those who do not use alcohol. Use of caffeine can similarly disturb one's sleep, with caffeine use being more detrimental to nighttime sleep as the day goes on. Firefighters should strive to reduce their caffeine intake as much as possible, and completely eliminate its consumption in the afternoon and evening. Firefighters seeking to improve their sleep should commit to following a strict sleep and wake schedule to promote a healthy circadian rhythm (Yong et al., 2016). Similarly, they should avoid behaviors that can contribute to circadian misalignment, like eating during the night or excessive napping during the day. Finally, firefighters should commit to observing these same sleep hygiene practices while on-duty whenever possible.

Firefighters must know the importance of good sleep and commit to achieving it whenever possible, but in order for change to happen, firefighters can't be the only ones working at it. Fire departments should also commit to supporting good sleeping habits whenever possible. For example, consideration should be given to making firefighter sleep environments private. Sleeping quarters should be equipped with blackout curtains or some other means of minimizing light in the room, and temperature control systems should be in place to ensure cool sleeping conditions. Alerting systems should function on an as-needed basis to reduce unnecessary disruptions. Fire departments should give consideration to the installation of selective alerting systems wherever possible so that alarms only disrupt the sleep of assigned companies during the night. Napping should be encouraged during the day and consideration should be given to the hours that shift changes occur so that all companies can maximize uninterrupted sleep. Further studies should elicit firefighter feedback regarding the challenges they face to achieve enough quality sleep while on-duty so that efforts can be made to address the problem of on-duty sleep deprivation.

This study revealed that firefighters are not getting enough sleep while on-duty and that chronic sleep debts may be related to their health and wellness. Measures aimed at identifying sleep problems and improving firefighter sleep hygiene could have lasting and expansive health benefits, with relatively little cost to fire departments, and great benefits to the communities that firefighters serve. As a physiological need, the topic of sleep health will be more easily accepted in the fire service, making it an excellent proxy for social workers and other mental health professionals to introduce more stigmatized topics, like mental health, substance use, and firefighter suicide. It is of great public interest to invest in these emergency responders by addressing the issue of sleep deprivation in the fire service.

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Appendix A

Survey Questions

Qualifying statement:

Indicate whether the following statements are true or false to ensure you qualify to participate in this study:

I am a professional firefighter, assigned to the suppression branch of a full-time fire department.
I can read/understand English and am 18 years of age or older.

- A. True
- B. False

1. For how many years have you been a professional firefighter?

- A. Less than 5
- B. 5-10 years
- C. 11-15 years
- D. 16-20 years
- E. 21 years or more

2. To which type of operations are you most typically assigned?

- A. Engine/Pumper
- B. Ladder/Truck
- C. Both Engine and Truck (ie: tramps, swing crews, Quints)
- D. Specialty Rescue (ie: USAR team, Hazmat, Heavy Rescue)
- E. Command or Support (ie: Battalion Command, Air Supply, Salvage)
- F. Ambulance or Medical Unit only
- G. Other _____

3. How many hours do you work during a typical shift?

- A. Under 12
- B. 12-24
- C. 25-36
- D. 37 or more

4. Since becoming a firefighter, have you been diagnosed by a medical professional with any of the following cardiovascular issues: hypertension (high blood pressure), coronary artery disease (atherosclerosis, hyperlipidemia), arrhythmia (irregular heartbeat), myocardial Infarction (heart attack)?

- A. Yes
- B. No

If YES, which? Check all that apply

- Hypertension
- Coronary Artery Disease

Arrhythmia
Myocardial Infarction

5. Since becoming a firefighter, have you been diagnosed by a medical professional as obese?

- A. Yes
- B. No

6. Since becoming a firefighter, have you been diagnosed by a medical professional with Insomnia?

- A. Yes
- B. No

7. Since becoming a firefighter, have you been diagnosed by a medical professional with Sleep Apnea?

- A. Yes
- B. No

If YES, do you use a CPAP as instructed?

- A. Yes, both on and off-duty
- B. Yes, but only off-duty
- C. Yes, but only on-duty
- D. No

8. Since becoming a firefighter, have you been diagnosed by a medical professional with any other Sleep Disorder?

- A. Yes _____
- B. No

9. Since becoming a firefighter, have you been diagnosed or treated by a health professional for any of the following: depression, anxiety, Post-Traumatic Stress Disorder (PTSD)?

- A. Yes
- B. No

If YES, Which? Check all that apply

Depression
Anxiety
PTSD

10. On average, how many full hours do you sleep during the night *while on duty*?

- A. 0-2
- B. 3-4
- C. 5-6
- D. 7 or more

11. On average, how many full hours do you sleep during the night *while off duty*?

- A. 0-2

- B. 3-4
- C. 5-6
- D. 7 or more

12. Which of the following best describes the environment in which you typically sleep *while on duty*?

- A. A shared space (ie: dormitory or barracks)
- B. A private room
- C. It varies

13. Which of the following best describes the environment in which you typically sleep *while off duty*?

- A. A shared space (ie: dormitory or barracks)
- B. A private room
- C. It varies

14. Once you lay down, how long does it typically take for you to fall asleep?

- A. Less than 5 minutes
- B. More than 5 minutes, but less than 30
- C. More than 30 minutes

15. (EPSWORTH SLEEPINESS SCALE- Sum of All Answers)

Read the following 8 situations. Then, using the scale below, rate each one on the likelihood of you falling asleep/dozing off in the situation, given your recent experience.

0 = would **never** doze

1 = **slight chance** of dozing

2 = **moderate chance** of dozing

3 = **high chance** of dozing

<u>Situation</u>	<u>Chance of Dozing (0-3)</u>
Sitting and Reading	_____
Watching TV	_____
Sitting, Inactive, In a Public Place (ie: theater, meeting)	_____
As a Passenger in a Car for an Hour Without a Break	_____
Lying Down to Rest in the Afternoon When Circumstances Permit	_____
Sitting and Talking to Someone	_____

Sitting Quietly After Lunch Without Alcohol _____

In a Car, While Stopped for a Few Minutes in Traffic _____

TOTAL (ESS SCORE): _____

16. Which of the following have you used in the past year to help you fall asleep? Check all that apply

Over-the-counter sleep aids

Prescription sleep aids

Herbal supplements (ie: melatonin)

Alcoholic beverages

Non-prescription/recreational drugs (ie: marijuana, opiates)

I don't use any sleep aids or practices

17. Which of the following have you used in the past year to help you stay awake? Check all that apply:

Over-the-counter wakefulness aids

Prescription wakefulness aids

Herbal supplements

Caffeinated beverages/energy drinks

Non-prescription/recreational (ie: cocaine, methamphetamine)

I don't use any wakefulness aids

18. Do you think, or has someone close to you ever expressed concern, that you may suffer from a problem with alcoholism or drug addiction?

A. Yes

B. No

C. I'm not sure

D. I prefer not to answer

19. Since becoming a firefighter, have you been professionally diagnosed with, or treated for, a Substance Use Disorder (drug addiction and/or alcoholism)?

A. Yes

B. No

If YES, did/do you seek professional treatment and/or work a recovery program for the Substance Use Disorder?

A. Yes

B. No

20. Are you a veteran?

- A. Yes
- B. No

If YES, have you ever been deployed?

- A. Yes
- B. No

21. Of the following, which aspects of your health and well-being do you feel need the most attention or improvement? *Check all that apply*

Physical Health
 Mental Health
 Fitness/Exercise
 Sleep
 Spirituality
 Social Connectedness
 Security
 Intimate Relationships
 Substance Use/Addiction
 Self-Esteem
 Finances
 Legal Issues
 Parenting/Family

22. Which of the following wellness resources would you use if they were available, convenient, and affordable?

Medical Professionals or Specialists (ie: Doctors, Primary Care Clinics, Physical Therapists)
 Psychiatric Professionals or Specialists (ie: Psychiatrists, Therapists, Group Therapy)
 Marriage/Family Therapy (ie: Couple's Counseling, Family or Child Therapy)
 Sleep Specialists (ie: Sleep Clinics, Sleep Hygiene Education)
 Integrative Care Professionals (ie: Chiropractors, Massage Therapists, Acupuncture)
 Physical Fitness (ie: Gym Membership, Personal Trainer, Exercise Program)
 Addiction Resources (ie: Treatment Facilities, Alcoholics/Narcotics/Gamblers/Etc. Anonymous)
 Self-Help (ie: Literature, Podcasts, Online Programs)
 Spirituality (ie: Religion, Spiritual Practice)
 Peer Support Groups (ie: MN Firefighters Peer Support)
 Employee Assistance/Health Insurance Programs
 Daycare/Dependent Care
 Financial Advisors
 Legal Advisors

The following demographic information is being collected so that the findings of this study can be compared to the general population. Demographic information will be analyzed collectively and will not be used to identify individual participants in this study. All answers are completely voluntary and you may skip any that you do not want to answer

23. What is your gender?

A. Male

B. Female

C. Other _____

24. How would you best describe your race? Check all that apply.

Caucasian or White (origins in Europe, Northern Africa, and the Middle East)

African American or Black (origins in Africa, except Northern Africa)

American Indian or Alaskan Native (origins in North, Central, and South Americas)

Asian (origins in the Far East and Southeast Asia, including the subcontinent of India)

Native Hawaiian or other Pacific Islander (origins in any of the Pacific Islands, such as Hawaii, Guam, or Samoa)

I identify with two or more races

Other _____

25. Are you of Latin/Hispanic descent?

A. Yes

B. No

26. What is your age? _____

Appendix B

***[1147116-1] Sleep and the Health of Firefighters***

The purpose of this study is to collect information about firefighter health, with a focus on their sleep. You were selected as a possible participant because you are a professional firefighter for a full-time fire department, assigned to the suppression branch of that department.

This study is being conducted by: Bridget A. Bender, Dr. Courtney Wells, and the School of Social Work at the University of St. Thomas. This study was approved by the Institutional Review Board at the University of St. Thomas.

If you agree to participate, I will ask you to answer several survey questions focused on your health, with an emphasis on your sleep. The survey should only take ten minutes or less to complete.

This study has minimal risks. Due to the personal, health-related nature of the questionnaire, it is possible that answering its questions could cause emotional distress, or a tendency to self-diagnose. To minimize this risk, I have asked only questions that are pertinent to my study and have differentiated between questions that ask for diagnoses made by a medical professional, and questions that are self-reflective. If you choose to participate and find that you have any concerns regarding your sleep health, please feel free to visit the following websites, which contain information regarding sleep health and available resources:

<https://sleepfoundation.org/sleep-disorders-problems>

<https://www.webmd.com/sleep-disorders/sleep-disorders-resources>

<https://www.cdc.gov/sleep/resources.html> .

There are no direct benefits to you for participating in the study.

The records of this survey will be kept confidential. In any sort of report I publish, I will not include information that will make it possible to identify you. Your employer and supervisors will not know whether you choose to participate, nor will your employment be affected by your decision.

Your participation in this study is entirely voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of St. Thomas. If you decide to participate, you are free to withdraw at any time up to and until the survey is submitted. You may withdraw by closing the survey on your computer. You are also free to skip any questions I ask.

You may ask any questions you have now and any time during or after the survey by contacting the researcher. You may contact me (Bridget Bender) at: nels2097@stthomas.edu or 612-280-2596, and Dr. Wells at: well7613@stthomas.edu or 651-373-6651. You may also contact the University of St. Thomas Institutional Review Board at (651) 962-6035 or muen0526@stthomas.edu with any questions or concerns. **Please print this form to keep for your records.**

By clicking on the link below, you consent to participate in the study and will begin the survey.

https://stthomas.az1.qualtrics.com/jfe/form/SV_2hnm8AhbEOndULr