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Elisabeth J. Filiss

University of San Francisco, lisafiliss@yahoo.com

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Improving Firefighter Health Through Education in Sleep Science

Elisabeth J. Filiss

University of San Francisco

Cynthia Huff DNP, RN, OCN, CRNI CNL

Abstract

Sleep impacts all aspects of life, from mental health to physical well-being to job performance. Nowhere is this more important than in the fire service, where extreme working conditions are the norm. One of 44 stations in a large fire department (XFD), Firehouse X, has 21 full-time members, six on duty per shift. A microsystem assessment of Firehouse X revealed poor sleep habits and environmental factors that are not conducive to quality sleep. The role of sleep in the fire service has recently been examined, and interventions aimed at improving firefighters' sleep have been recommended.

This quality improvement project implemented a four-week educational program on sleep science in Firehouse X from May to July 2024. Members were provided with educational materials in various formats weekly. A station sleep champion kept members engaged in the program. Environmental changes were supported. Members were surveyed before and after implementation using the Pittsburgh Sleep Quality Index (PSQI). The aim of this project was to improve sleep quality by 25% over four weeks and have 90% participation. 17 of the eligible 18 members participated in the first survey, but an additional two were unavailable for the 4-week follow-up. Thus, participation fell from 94% to 83%. Results demonstrated that all but one member improved their sleep scores, with three members improving by over 25%. However, the average percent improvement was 15%, falling short of the 25% goal. These results demonstrate the effectiveness of educating firefighters in sleep science. This program can be expanded to other firehouses in XFD.

Keywords: sleep, firefighters, first responders, health, cardiovascular, mental health.

Personal Leadership Statement

As I approach the end of a 30-year career with the fire service, I am excited to discover the next chapter of my life. My education at the University of San Francisco (USF) has given me the knowledge, skills, and abilities necessary for any future endeavor. Moreover, this program has shown my strengths, clarified my values, and guided my vision. When I began my career as a firefighter, I focused on one task at a time. As a firefighter/paramedic, I was responsible for the treatment each patient received. Now, as a paramedic captain, I am responsible for the entire 911 system. A system that relies on the dispatchers, paramedics, and firefighters that respond to those 911 calls. As my career has expanded, so has my focus. I now take a global, holistic view of our department and realize our success is dependent on the long-term health of our membership.

Don Clifton, the first to study positive psychology, found that great leaders know their strengths and utilize them to their advantage (Gallup, 2008). The Clifton Strengths Assessment validates my beliefs about my leadership strengths. I score high on developer and empathy. My learner, intellection, and input traits highlight my strategic thinking. Of the many theories Wei and Horton-Deutsch (2022) presented, I find that Watson's Caring Theory and Transformational Leadership Theory resonate with how I approach my work and care for my crews. I am an example of open-hearted practice and am responsible for providing a workplace that fosters those qualities. I have been a volunteer member of our Peer Support and Critical Incident Response Teams (CIRT) for nearly a decade. I model self-care and advocate for work-life balance. I will continue to espouse and model the benefits of a healthy lifestyle. Sleep is also essential to overall well-being.

The Department has a mission statement that reaches beyond the daily operations of saving lives and property. We strive to provide a work environment that values health and

wellness (San Francisco Fire Department, n.d.). There is a newly created Division of Health and Safety. The Department's Physician's Office, staffed with a doctor and a nurse practitioner, has been renamed the Office of Employee Health. The "30 in/30 out" initiative aims to enable both a full 30-year career and a 30-year retirement. This initiative is a collaboration between the Department's Office of Employee Health and the Health and Safety Division and focuses on cardiovascular health, cancer prevention, and mental health (Brokaw & Phelps, 2022). This quality improvement (QI) project falls under this initiative. Sleep is an essential component of physical and mental health. This program will improve health and save lives by providing firefighters with the knowledge and tools to improve their sleep.

Problem Description

Poor sleep significantly affects firefighter health, both physical and mental. Khoshakhlagh et al. (2023) performed a meta-analysis and found that thirty percent of firefighters have sleep disorders, and over half reported poor sleep quality. Poor sleep quality affects several measures of long-term health. A systematic review by Frost et al. (2021) found an association between inadequate sleep and increased cardiovascular disease (CVD) and mortality in firefighters. In addition, increased inflammatory markers and cortisol levels were associated with CVD and cognitive impairment. A review by Ahmad and Didia (2020) found poor sleep to be associated with increased cardiovascular morbidity and mortality. In addition, the researchers found poor sleep linked to depression and impulsive behavior. Performance on critical thinking and reaction times were also impacted by poor sleep. Nearly one in three first responders develop PTSD, and 20% of those will also develop substance use disorder (SAMSA, 2018).

Firefighters work 24-hour shifts, living in and responding from the firehouse. This includes sleep, which is often interrupted by dispatches. Firefighters report poorer sleep metrics

than the general population, both on and off duty (Khoshakhlagh et al., 2023; Stout et al., 2021). However, a small study showed a remarkable improvement in firefighters' resting heart rate, blood pressure, and sleep disturbances with changes to the sleep environment (Carey et al., 2018). Evidence shows that sleep positively affects firefighters' physical and mental well-being (Frost et al., 2021).

A firehouse is a unique location, a combination of a deployment center, a training facility, and a home. Shifts are 24 hours long and spent in close quarters. The day has a rhythm: a morning meeting, building inspections, training, shopping, and cooking lunch and dinner, all while responding to 911 calls as they are dispatched. Firefighters sleep in the dorm, a large open room with twin beds in semi-private cubicles, and officers have private bedrooms.

A gap analysis revealed many opportunities to improve sleep hygiene at Fire Station X (Appendix A). Ambient temperature and lighting were noted to fluctuate throughout the day. Nighttime temperatures were elevated. Fluorescent lights were left on in the halls and bathrooms. Shades were drawn in the mornings, blocking natural light. Members were noted drinking coffee in the afternoon and scrolling their phones late into the evening. At night, dispatch alerts woke every member regardless of who was dispatched. Firefighters expressed feeling tired in the morning regardless of call volume. They also report difficulty falling, staying, and returning to sleep after waking.

A recent review of empirical evidence (Irish et al., 2015) suggested a positive association between individual sleep hygiene recommendations and nocturnal sleep. A small feasibility study showed that reducing ambient light, maintaining a comfortable temperature, and eliminating unnecessary alarms remarkably improved firefighters' resting heart rate, blood pressure, and sleep disturbances (Carey et al., 2018). An integrated review (Mantua et al., 2019) found that

simple measures such as black-out curtains, fans, and white noise machines effectively improved the sleeping environment.

Specific Project Aim

This project aims to improve sleep quality by 25% over baseline in firefighters assigned to Firehouse X by July 2024.

Available Knowledge

PICOT Question

In firefighters (P), how does an educational program on sleep science (I), compared to no intervention (C), affect firefighter sleep quality (O) at one and six months (T) after implementation?

Search Strategy

A systematic search was conducted of several databases: Pubmed, Joanne Briggs, DynaMed, Cochrane/DARE, and CINAHL. Search terms included sleep, circadian, environment, and education. The truncated root of fire* was also used to capture terms such as firefighter, firemen, and firehouse. The search was limited to articles written between 2017 and 2024 in English and conducted in the United States. Finally, the type of article was restricted to systematic reviews, meta-analyses, critically appraised, and individual research studies.

The initial search found 184 articles. These articles were first reviewed by examining their title and abstracts. Then, their methodology and design were examined. This produced a list of 17 articles that met search criteria and were relevant to the topic. The top six were selected for further review. Finally, the Johns Hopkins Evidence-Based Practice Model for Nursing and Healthcare Professionals (JHNEBP) Appraisal Tool was used to appraise the evidence (Appendix B).

Carey et al. (2018) led a quasi-experimental study on a small sample of firefighters to assess the effect of environmental changes on sleep and cardiac burden in firefighters. The environmental changes studied were reduced light levels, temperature control, and ambient noise reduction. Sleep disturbances and resting heart rate and blood pressure were reduced. This study showed that sleep and health are improved with changes to the firehouse dormitory.

Frost et al. (2021) conducted a systematic review of 15 articles to assess the effects of sleep on firefighter performance and health. Poor sleep was consistently associated with decreased cognitive performance. Poor sleep affects health measures, including heart rate variability, resting heart rate, inflammatory markers, and cortisol levels. The authors recommend incorporating the influence of environmental factors in sleep hygiene education for firefighters.

A systematic review with a meta-analysis of 47 articles was conducted by Khoshakhlagh et al. (2023). The authors found a 30% prevalence of sleep disorders among firefighters. 51% of firefighters reported poor sleep quality. Shift work and mental health were cited as contributors to poor sleep. The authors also found that injuries, pain, and body mass index (BMI) were associated factors. This analysis highlights the need for sleep health promotion programs for firefighters.

An integrated review by Mantua et al. (2019) addressed environmental barriers to obtaining adequate sleep in the military. The review outlined environmental sleep disruptors, described their occurrence in the military context, and discussed feasible mitigation strategies. Findings conclude that ambient light affects the circadian rhythm and the sleep-wake cycle. The authors note that measures such as black-out curtains can significantly reduce ambient light. Similarly, simple measures like white noise machines and acoustic absorbers can reduce sleep disruption.

A non-experimental study by Stout et al. (2021) assessed the impact of the 24-hour shift on sleep quality and quantity, attention, vigilance, processing speed, and mental health. This study showed that firefighters have poorer sleep quality and quantity than the public, both on and off duty. Their results suggest a negative effect on cognitive function, an increased risk of injury, and decreased performance. This study is especially relevant to this project as it was conducted in a department with the same shift schedule as Firehouse X. The researchers suggest exploring the firefighters' environmental conditions and behavioral activities that may contribute to poor sleep.

Zhong et al. (2022) are conducting an ongoing prospective study in another population, a cohort of 51,562 California teachers. Participants were surveyed to evaluate the effect of environmental factors, including noise, light, green space, and air pollution, on self-reported sleep quality. Geocoded data was obtained from the National Parks Services (sound map), the New World Atlas (artificial light at night), NASA (enhanced vegetation index), and the EPA (air pollution). This research found that environmental disruptors negatively impact sleep onset, duration, and quality.

The evidence in these six studies supports the need for an educational plan on sleep science for firefighters. Poor sleep is shown to impact the performance and health of firefighters negatively. These studies find that environmental changes can improve sleep quality. Firefighter health is shown to improve with the quality of their sleep. Educating firefighters on behavioral and environmental changes that they can implement will empower them to improve their sleep and overall health.

Rationale

Kotter and Cohen's eight-step change model will be applied to the design and implementation of this QI project (Melnyk & Fineout-Overholt, 2023). Kotter and Cohen assert that emotional investment is vital to lasting change. The first two steps of Kotter's model, creating urgency and a coalition, will be accomplished by a station sleep champion, an individual who understands the importance of sleep and is passionate about improving firefighter health. Step three, getting the vision right, requires a strategic quality improvement (QI) process that considers the evidence and the constraints of department bureaucracy. Step four, communication, will be accomplished by the Peer Support members of the Health and Safety Division, who are embedded in every station. They are well-respected members who can affect culture change. The Station Captain has the authority to implement change and will gain the knowledge and tools to do so from this program (step 5, empower). The final three steps, short-term wins, perseverance, and culture change, are exercises in public relations. The station sleep champion and peer support members will track and continue to celebrate improvements in sleep.

Context

A microsystem assessment of Firehouse X revealed a deficit in sleep science knowledge among firefighters. Firehouse X is one of 45 stations in a large metropolitan department (Department X). This station has 21 full-time equivalents (FTEs) assigned. Six members are on duty per shift: three firefighters and one officer (Lieutenant or Captain) staff the fire engine. There is also one Battalion Chief, who supervises four firehouses, and one Rescue Captain, who supervises emergency medical services (EMS).

Many factors influenced the success of a sleep education plan for Fire Station X, as illustrated by a Strengths, Weaknesses, Threats, and Opportunities assessment (Appendix C). The

most significant internal strength is the motivation of both Fire Station X and the Behavioral Health Unit (BHU) of the Health and Safety Division. The firefighters of Station X have expressed interest in improving their sleep. The BHU is positioned to support the project with funding, lobbying, and dedicated staff. The Department also has a robust Division of Training (DOT) with an existing online training platform. This platform will be utilized to expand this project. Finally, the Department has a dedicated grant writer who will be instrumental in securing funding.

External opportunities include several funding sources and new research. Multiple government programs and grants are available for firefighters' health and safety (U.S. Department of Homeland Security, 2024). Additionally, non-profit organizations such as the National First Responders Fund (NFRF, 2024) and the Gary Sinise Foundation (2024) fund firefighter mental health and wellness initiatives and training. Research links sleep with physical and mental health, performance, and safety (Carey et al., 2018; Frost et al., 2021; Irish et al., 2015). These goals align with those of Department X (Brokaw & Phelps, 2022). Finally, quantified self-health and fitness tracking (QSHFT) devices, such as the Oura ring, effortlessly track sleep metrics. The Oura ring has proved comparable to actigraphy, the standard medical device for tracking sleep, in measuring many sleep parameters (Sarhaddi et al., 2020).

Firefighters who own such a device can utilize their data for survey responses.

There are potential obstacles to any successful project. Often, it is the senior employees that resist change. It is essential to get buy-in from these members and enlist them to lead any culture shift (Melnik & Fineout-Overholt, 2023). Confidentiality may be a concern for participants and the Department. Quantified self-health and fitness tracking (QSHFT) devices are not considered medical devices by the FDA. Therefore, their data is not protected under HIPAA

(Brinson & Rutherford, 2020). This would lessen liability for the Department. However, the developers of this program understand the importance of privacy and trust. The participants will self-report their biometrics. Confidential information will only be viewed by the Nurse Practitioner (NP). The ability to change the configuration of the sleeping dorms and the existing alert systems has the potential to have a significant impact. Unfortunately, the aging firehouses are not amenable to change. The budget represents both internal and external considerations. Competing budget priorities weaken this project's chances. City-wide budget cuts threaten the Department's funding. Finally, constant stimulation from modern culture and digital devices encourages poor sleep hygiene.

Many Officers in this Fire Department can influence this project (Appendices D and E). Command Staff has final authority over any project moving forward. In addition, the Station Captain makes decisions regarding the firehouse. The Chief of Health and Safety and the Nurse Practitioner of the Office of Employee Health are interested in this project and are positioned to influence its success. Academic advisors are highly interested in the success of the QI project. Though they do not influence the organization, they have abundant influence on the student and the project's course. As firefighters become aware of the project, their interest will grow. Although they do not influence the project moving forward, their participation will be essential.

Intervention

The intervention will involve presenting firefighters with a comprehensive educational program in sleep science (Appendix F). This 4-week program will include evidence-based recommendations for modifying the sleeping environment, adjusting behaviors, and optimizing diet. Firefighters will be guided and supported in implementing these changes to their sleep environments. Regular check-ins will be conducted to encourage and motivate firefighters in

their journey toward better sleep. The intervention is expected to change firefighters' sleep habits and environments significantly. These changes, in turn, are anticipated to lead to improved sleep quality and overall health.

The cost of implementation is minimal (Appendix G). Team members were able to meet during regularly scheduled hours. The intervention is a curated list of materials sourced from scholarly journals, podcasts, and original content created by the MSN student. The assessment tool also included open-source content.

This program proves to be financially feasible due to significant cost avoidance. It is posited that firefighters will change their daily habits and sleep environments when they understand sleep science. Improved sleep will lead to better physical and mental health. The financial model was built on average hospitalization costs, disability claims, and hourly wages of fire personnel (Appendix H). Eliminating one cardiac and one mental health leave results in a total avoidance cost of \$414,000. A significant portion of the implementation costs are the wages of both the developers of the program and the overtime paid to the firefighters attending the training. Nominal supplies and wages total \$6,544.00. By subtracting implantation costs from those avoided, this program realizes a net savings of \$407,456. These costs can be reduced significantly by conducting training during regularly scheduled hours. A cost-utility analysis shows additional benefits. Firefighter performance has been shown to improve with sleep (Stout et al., 2021). Job satisfaction would likely improve, and interpersonal conflict may decline.

Study of the Intervention

Several iterations of this QI project were considered. A focus group was created consisting of the station sleep champion, the Department's Nurse Practitioner (NP), and the MSN student. Plan, do, study, act (PDSA) cycles were utilized to refine the intervention and choose an

evaluation tool (Appendix I). A Project Charter was created to guide the design and implementation of this quality improvement (QI) project (Appendix J). Staff participation was utilized as a process measure. A balancing measure of zero increase in response times was also tracked.

Sleep quality was assessed utilizing the Pittsburgh Sleep Quality Index (PSQI). (Appendix K) The PSQI assessment addresses quality and consistency. It comprises 19 questions that address seven components of sleep: subjective quality, latency, duration, efficiency, disturbances, use of medications, and daytime dysfunction. The assessment provides a sleep quality score (Appendix L). A lower score reflects good quality sleep. A score over 25 indicates a need for improvement. The PSQI is designed to be administered at one-month intervals (Buysse et al., 1989). The PSQI was administered prior to the intervention and again at four weeks. Participation was reflected by the number of PSQI assessments completed. The Department's computer-aided dispatch (CAD) system was queried to determine baseline response times. Response times during implementation were compared to the station's baseline.

Ethical Considerations

The Ignatian value of Cura Personalis defines a core tenant of nursing. This value describes attending to the whole person and all their needs. Cura Personalis acknowledges the interrelationship between bio-, psycho-, and social supports necessary for healing (University of San Francisco, n.d.). Provisions 1.5 (relationship with colleagues) and 6.3 (responsibility for the healthcare environment) of the American Nurses Association's (ANA) Code of Ethics (ANA, 2015) align with this department's goal to improve the health and well-being of firefighters.

Healthcare workers are demanding, and organizations see the value of a sustainable work-life balance. Resiliency is recognized as an essential component of a healthy workforce.

(Morris, 2022). Provision 5 of the Code is entirely dedicated to the Duty to Self (American Nurses Association, 2015). This provision recognizes that providers are more effective when they are healthy. This QI project reflects these values with the aim of improving the health of firefighters.

A statement of non-research determination (Appendix M) was submitted to the University of San Francisco School of Nursing and Health Professions Institutional Review Board (IRB). This project has been approved as a quality improvement project by faculty using QI review guidelines and does not require IRB approval.

Outcome Measure Results

Firehouse X has 21 members; however, three probationary members were reassigned to other firehouses. Newly assigned members were not enlisted in the educational program. The number of eligible members was adjusted from 21 to 18, with 17 responding to the first survey. Participation in the pre-intervention assessment was 94% (n=18), exceeding the goal of 90% participation. Two members were on vacation during the 4-week follow-up assessment, dropping participation to 15 members or 83% (n=18).

Members of Firehouse X took the PSQI to assess sleep quality before and after implementation. The PSQI is a 100-point scale with lower values reflecting quality sleep. The average pre-intervention score was 37, adjusted to 42, with two firefighters who did not complete the program removed. One firefighter received a score lower than the 25-point cut-off for quality sleep before implementation. Post-intervention scores improved for all but one firefighter, with an average drop of 6.5 points. Individual scores improved by an average of 15%, with one firefighter improving by 32% (Appendix N). The number of firefighters with scores lower than 25 (the PSQI cut-off for quality sleep) rose from one to five post-intervention. Dispatch times

(from the announcement to leaving the firehouse) were monitored as a process measure and were not affected by the intervention.

Exit interviews were conducted to determine which sleep improvement measures were implemented. Firefighters reported making environmental changes, including red-spectrum night lights instead of fluorescents and black-out curtains in the dormitory. Behavioral changes included reducing afternoon caffeine and phone use before bed. Members also listed increasing exposure to natural light in the morning and spending more time in nature as beneficial.

Summary

Key findings of this QI project include improved sleep quality with no impact on dispatch times. Members were highly motivated and initiated many changes to the firehouse dormitory. The pre-implementation PSQI results for Firehouse X were in line with research indicating that firefighters' sleep quality, both on and off duty, is lower than that of the general public (Khoshakhlagh et al., 2023). A post-implementation improvement of 15% indicates that education in sleep science changes behavior and motivates change.

The implementation costs of this QI project were estimated at \$6,544.00, but they would likely be lower as most work would be performed during regular hours, avoiding overtime. A cost-avoidance analysis (CAA) was performed, comparing implementation costs with one cardiac event, one stress leave, and the resulting disability pay (DP). The CAA determined that this program would save \$407,456.00 (Appendix H).

Lessons learned for future QI projects include timing implementation when regular members are scheduled, as several were on vacation during the summer months. This QI project was implemented as part of graduate school requirements, and as such, the timeline was dictated by due dates. This interrupted the natural flow of PDSA cycles. The accelerated timeline also

limited the scope of the intervention. Future programs should address sleep at the firehouse and home. This firehouse was exposed to this QI project as it was being created, which may have influenced its impact as many members were familiar with sleep science. Applying this QI project to other firehouses in XFD may have more impactful results.

Educating firefighters on sleep science proved effective in improving their sleep quality. The presence of a sleep champion in the firehouse kept the members motivated. This sleep champion not only encouraged participation but also shared knowledge of sleep science and modeled good sleep habits. *Cura Personalis* is embedded in this QI project as it is guided by a desire to care for the whole person, especially as these firefighters so often care for us.

Conclusions

This QI program is scalable to the greater fire service. This program addresses a foundational component of health: sleep, which is tied to mental and physical wellness. This educational program is a useful low-cost intervention for firefighters to improve their sleep. The potential benefit goes beyond cost savings and preventing disability leave. This program will have a negligible impact on operations but has the potential to improve performance, safety, and job satisfaction.

This Department's Mission Statement includes the health and safety of its members. This program addresses both. Members of the BHU, the Physician's Office staff, and this MSN student are dedicated to improving our members' health outcomes. Research and funding opportunities are abundant. This lesson plan is just one tool in the toolbox for firefighter wellness. Future firehouse builds should incorporate current research on environmental factors that affect sleep. Private quarters, intelligent unit-specific dispatch systems, and ambient light

and temperature controls can all lead to better sleep. For now, teaching firefighters simple, cost-effective changes they can make to their sleep will improve their health.

Sleep has a positive effect on both mental and physical health. Cognition, performance, and, by extension, safety all improve with sleep. Firefighters understand and accept that they will be awoken at night to respond to emergencies. They should not accept poor sleep in between those calls. These are specific and actionable changes to current habits and firehouse environments that can be easily implemented. A well-rested membership is healthy, effective, and resilient.

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Appendix A: Gap Analysis

<p>Area under consideration: Implementation of an educational program for firefighters to improve sleep, thus improving health and reducing cardiac events and stress leave. AIM statement: To improve firefighter sleep quality by 25% over baseline by July 2024 in Firehouse X.</p>		
Desired State	Current State	Action Steps
Behavior changes resulting in fewer awakenings and more restful sleep	Lack of knowledge regarding sleep science, resulting in poor sleep and unnecessary awakenings	Outline, propose, and receive approval for curriculum
Sleep science information disseminated to Department	No training in sleep science	Collaborate with the Division of Training (DOT) and Health & Safety Division to schedule, research, and develop course and materials
Department members with access to sleep science information	No available information on sleep science	Format and upload to Target Solutions (online training platform)
Supported learning of sleep science	No Department initiative in firefighters' sleep improvement	Assign online training to firefighters
Department commitment to improving firefighters' sleep	No support for firefighters' sleep	Health & Safety staff to visit firehouses to reinforce training and provide resources
Means of measuring improvement in firefighters' sleep	No means of measuring sleep data	Grant proposal: Funding for Oura rings

Appendix B: Evaluation Table

PICOT Question

In firefighters (P), how does an educational program on sleep science (I), compared to no intervention (C), improve sleep knowledge and quality (O) at 1 and 6 months (T) after implementation?

Study	Design	Sample	Outcome/Feasibility	Evidence rating
Carey et al. (2018). A quiet firehouse: Reducing environmental stimuli among professional on-duty firefighters. <i>Journal of Occupational and Environmental Medicine</i> , 60 (2), 186-190. https://doi.org/10.1097/JOM.0000000000001199	Quasi-experimental	24 firefighters began the study; 11 completed	Finds changes to firehouse sleeping environment improve quality of sleep Useful as changes firefighters can implement themselves	II C
Frost, C., Toczko, M., Merrigan, J.J., & Martin, J.R. (2021). The effects of sleep on firefighter occupational performance and health: A systematic review and call for action. <i>Sleep Epidemiology</i> , 1(100014-). https://doi.org/10.1016/j.sleep.2021.100014	Systematic Review	15 Articles	Finds firefighters with poor sleep metrics have poor overall health metrics and lower cognitive performance. Recommends sleep education interventions	II A
Khoshakhlagh, A.H., Sulaie, S.A., Yazdanirad, S., Orr, M., Dehdarirad, H., & Milajerdi, A. (2023). Global prevalence and associated factors of sleep disorders and poor sleep quality among firefighters: A systematic review and meta-analysis. <i>Heliyon</i> , 9(2). https://doi.org/10.1016/j.heliyon.2023.e13250	Systematic Review with Meta-Analysis	47 Articles	Finds firefighters have a higher prevalence of sleep disorders and poor sleep quality. Confirms the need for a sleep educational program for firefighters	II A
Mantua et al. (2019). A review of environmental barriers to obtaining adequate sleep in the military operational context. <i>Military Medicine</i> , 184(7/8), e259–e266. https://doi.org/10.1093/milmed/usz029	Integrated Review	56 references	Finds sleep quality is impacted by environmental factors. Provides specific recommendations to mitigate effects of environmental disruptors.	IV C
Stout, J. W., Beidel, D. C., Brush, D., & Bowers, C. (2021). Sleep disturbance and cognitive functioning among firefighters. <i>Journal of Health Psychology</i> , 26(12), 2248–2259. https://doi.org/10.1177/1359105320909861	Non-experimental	45 Firefighters	Finds firefighters have poorer sleep quality than the general population, both on and off-duty. Firefighter	III B

			performance is affected by sleep quality.	
Zhong et al. (2022) Environmental influences on sleep in the California teachers study cohort. <i>American Journal of Epidemiology</i> , 191(9), 1532–1539. https://doi.org/10.1093/aje/kwab246	Prospective cohort study, ongoing	51,562 California Teachers	Finds environmental disruptors negatively impact sleep onset, duration, and quality. Finds that green space improves sleep metrics	III B

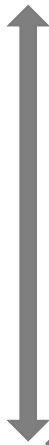

Appendix C: SWOT/C Analysis:

	Favorable/Helpful	Unfavorable/Harmful
Internal (attributes of the organization)	<p style="text-align: center;">Strengths</p> <ul style="list-style-type: none"> • Motivated firefighter population • Existing Division of Training with dedicated staff • Customizable online training platform that assigns and tracks training • Health & Safety Division staff to advocate for program funding • Grant Writer 	<p style="text-align: center;">Weaknesses</p> <ul style="list-style-type: none"> • Current configuration of firehouses' living quarters • Existing dispatch alert system in firehouses • Resistance to change from senior firefighters • Competing budget priorities of Command Staff (Chiefs in charge)
External (attributes of the organization)	<p style="text-align: center;">Opportunities</p> <ul style="list-style-type: none"> • Government programs and grants for first-responder health and safety • Non-profit organizations funding first-responder mental health and wellness initiatives • Wearable health technology that provides valuable feedback • Growing body of research in evidence-based practice 	<p style="text-align: center;">Threats/Challenges</p> <ul style="list-style-type: none"> • City X budget shortfall mandating Department budget cuts • Existing alarm systems may not be amenable to retrofit if needed • Modern culture, electronic devices, and social media apps encourage poor sleep hygiene

Appendix D: Communication Plan Matrix

Communication	Who	Frequency	Goal	Route
Academic Advisors				
	Cynthia Huff, instructor	weekly	Stay on track, focused	Email, zoom
	Susan Mortell, program director	weekly	Stay on track, focused	Email, zoom
	Stephanie Phelps, preceptor	Twice monthly or as needed	Keep advised, receive advice	Email, phone
Project Sponsors				
Health and Safety Division	Chief Alba	As needed	Keep advised, requests	Email
Office of Employee Health	Dr. Brokaw	As needed	Keep advised	Email
Site				
Firehouse X	Station Captain	Monthly	Keep advised, requests	In person

Appendix E: Power Interest Grid

Level of Power 	Keep Satisfied High Power, Low Interest	Manage Closely High Power, High Interest
	Command Staff: Chief of Department, Deputy Chief of Operations, Deputy Chief of Administration. Station Captain	Chief Alba, Division of Health and Safety Stephanie Phelps, NP, Preceptor
	Monitor Low Power, Low Interest	Keep Informed Low Power, High Interest
	Firefighters	Cynthia Huff, instructor Susan Mortell, program director Nursing Student
	Level of Interest 	

Appendix F: Sleep Science Course Outline

<i>Week</i>	<i>Topic</i>	<i>Content</i>
1	Introduction Orientation to Crediblemind.com Pre-Assessment Sleep in the Fire Service Shwag	PowerPoint https://sfhss.crediblemind.com/ Pittsburg Sleep Quality Index MSN Paper Custom Eye Masks
2	Check-in The Science of Sleep	Welcome https://www.listennotes.com/podcasts/the-science-of-the-science-of-a-good-nights-6biM231qv-l/
3	Check-in The Importance of Bedtime Routines	Welcome https://sfhss.crediblemind.com/faqs/how-can-i-get-a-better-nights-sleep-why-are-bedtime-routines-important https://www.listennotes.com/podcasts/life-kit/how-to-sleep-better-with-aC9PwKGF7qi/# https://sfhss.crediblemind.com/podcasts/episode-116-the-science-of-a-good-nights-sleep
4	Check-in Nature Therapy Other Remedies Conclusion & Gratitude	Welcome MSN Paper https://sfhss.crediblemind.com/topics/sleep?query=

Appendix G: Budget**Materials for Implementation**

<i>Task</i>	<i>Supplies</i>	<i>Cost</i>
Design	Adobe Acrobat Pro	\$240
Production	Paper & Ink	\$100
Shwag	Custom Eye Masks	\$385
	<i>Total Expenditures</i>	<i>\$725</i>

Avoidance Costs	Treatme nt Cost	Lost Wages					Total
1 M.I./ year	100,000						
Disability Pay (DP) x 1-yr Firefighter (FF)		\$196,000					
1 30-day PTSD retreat	\$20,000. 00						
DP x 6 months (FF)		\$98,000					
Total Avoidance Costs							\$414,000.00
Implementation Costs							\$6,544.00
Cost Savings							\$407,456.00

Appendix I: PDSA Cycles

Plan	Do
<ul style="list-style-type: none"> • Assess nature of problem • Explore teaching materials and assessment tools • Consider time on task and impact on operations 	<ul style="list-style-type: none"> • Research Current Sleep Science • Assess Baseline of Members • Assess amount and length of intervention
Act	Study
<ul style="list-style-type: none"> • Reduce content and streamline • Personalize interventions • Identify areas for improvement • Scale-up program to entire Department 	<ul style="list-style-type: none"> • Focus Group review intervention and assessment tools • Implement Intervention • Pre- and post- assessments

Appendix J: Project Charter

Project Charter: Improving Firefighter Health Through Education in Sleep Science.

Global Aim: To improve knowledge of sleep science, leading to improved sleep and better health in firefighters in Firehouse X by July 2024.

Specific Aim: To improve sleep quality by 25% over baseline by July 2024 in firefighters assigned to Firehouse X.

Background: Sleep impacts all aspects of life, from mental health to physical well-being to job performance. Nowhere is this more important than in the fire service, where extreme working conditions are the norm. Several studies have demonstrated the link between poor sleep and cardiovascular disease (CVD) (Frost et al., 2021 & Ahmad and Didia, 2020). Sleep has also been linked to depression and impulsivity. Cognition and performance decline with sleep deprivation (Khoshakhlagh et al., 2023 & Stout et al., 2021). One-third of firefighters will experience post-traumatic stress disability (PTSD) during their careers (Substance Abuse and Mental Health Services Administration [SAMSA], 2018). Firefighters report poorer sleep metrics than the general population, both on and off duty (Khoshakhlagh et al., 2023 & Stout et al., 2021). However, recent evidence shows that sleep positively affects firefighters' physical and mental well-being (Frost et al., 2021). Changes to the sleeping environment improve firefighters' resting heart rate and blood pressure (Carey et al., 2018). Khoshakhlagh (2023) and Frost (2021) performed literature reviews and recommend sleep education for firefighters.

Sponsors

Chief of Department	
Health, Safety & Wellness Chief	
Office of Employee Health	

Goals: To improve firefighter sleep quality by providing an educational program in sleep science and supporting environmental changes in Firehouse X.

Measures

Measure	Data Source	Target
Outcome		
% over baseline in sleep quality	Self-reported on Pittsburg Sleep Quality Index with data from quantified self-health and fitness tracker (QSHFT) wearable	25%
Process		
% participants completing course	Self-reported	90%
Balancing		
No increase in response times	Computer Aided Dispatch (CAD) Report	0% increase

Team

NP Co-Lead	
RN Co-Lead	
Health, Safety, Wellness Chief	
Behavioral Health Unit Captain	
Firehouse Captain	
Firehouse Sleep Champions	

Measurement Strategy

Background (Global Aim) To improve knowledge of sleep science, leading to improved sleep and better health in firefighters in Firehouse X by July 2024.

Population Criteria: Firefighters assigned to Firehouse X.

Data Collection Method: Sleep quality will be assessed using the Pittsburgh Sleep Quality Index survey. Participants will use self-reported sleep metrics gathered from personal quantified self-health and fitness tracker (QSHFT) devices such as Apple Watch, Fitbit, and Oura ring. If no QSHFT data is available, participants can self-report. The PSQI will be conducted prior to implementation and after the program's completion.

Data Definitions

Sleep Metrics	Data corresponding to sleep quality
Total Sleep	Total time asleep
Sleep Efficiency	Percent of time in bed asleep
Latency	Time to sleep onset
Wake after sleep onset (WASO)	Number of awakenings
Response time	Time to arrival on scene of 911 dispatch

Measure Description

Measure	Measure Definition	Data Collection source	Goal
Sleep Metrics	Data from personal QSHFT device, or self-reported.	Pittsburg Sleep Index Score	25% over baseline
Participation	% of staff completing course	Self-reported	90% participation
Response time	Time interval between dispatch and arrival on scene.	Computer Aided dispatch (CAD) system	No change

Gantt Chart

Educational Program for Firefighters to Improve Sleep in Firehouse X															
Task #	Description of Tasks & Communication Interventions	2023				2024					Responsible Party	Status			
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May					
	Preliminary Research, Develop Proposal	x	x											MSN Student	In Progress
	Approval to Proceed		x											Health & Safety (H&S) Chief	On Chief's Desk
	Develop Curriculum, pre- and post-tests, sleep journal			x	x	x								MSN Student & NP	
	Grant Proposal			x	x	x	x							MSN Student & Grant Writer	
	Create PowerPoint, digital surveys					x	x							Division of Training (DOT)	
	Receive Final Approval					x	x							H&S Chief	
	Present Training						x	x						MSN Student	
	6 month sleep dairies/Oura Ring Data							x	x	x	x	x	x	x	Participants/ MSN Student
	Evaluation of Data												x	NP/ MSN Student	

Appendix K: Pittsburg Sleep Quality Index

Subject's Initials _____ ID# _____ Date _____ Time _____ AM
 _____ PM

PITTSBURGH SLEEP QUALITY INDEX

INSTRUCTIONS:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?
 BED TIME _____
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
 NUMBER OF MINUTES _____
3. During the past month, what time have you usually gotten up in the morning?
 GETTING UP TIME _____
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)
 HOURS OF SLEEP PER NIGHT _____

For each of the remaining questions, check the one best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you . . .
 - a) Cannot get to sleep within 30 minutes

Not during the past month _____	Less than once a week _____	Once or twice a week _____	Three or more times a week _____
------------------------------------	--------------------------------	-------------------------------	-------------------------------------
 - b) Wake up in the middle of the night or early morning

Not during the past month _____	Less than once a week _____	Once or twice a week _____	Three or more times a week _____
------------------------------------	--------------------------------	-------------------------------	-------------------------------------
 - c) Have to get up to use the bathroom

Not during the past month _____	Less than once a week _____	Once or twice a week _____	Three or more times a week _____
------------------------------------	--------------------------------	-------------------------------	-------------------------------------

d) Cannot breathe comfortably

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

e) Cough or snore loudly

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

f) Feel too cold

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

g) Feel too hot

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

h) Had bad dreams

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

i) Have pain

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

j) Other reason(s), please describe _____

How often during the past month have you had trouble sleeping because of this?

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

6. During the past month, how would you rate your sleep quality overall?

Very good _____

Fairly good _____

Fairly bad _____

Very bad _____

7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all _____
 Only a very slight problem _____
 Somewhat of a problem _____
 A very big problem _____

10. Do you have a bed partner or room mate?

No bed partner or room mate _____
 Partner/room mate in other room _____
 Partner in same room, but not same bed _____
 Partner in same bed _____

If you have a room mate or bed partner, ask him/her how often in the past month you have had . . .

a) Loud snoring

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

b) Long pauses between breaths while asleep

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

c) Legs twitching or jerking while you sleep

Not during the past month _____ Less than once a week _____ Once or twice a week _____ Three or more times a week _____

Appendix L: Pittsburgh Sleep Quality Index (PSQI) Scoring Metric

Form Administration Instructions, References, and Scoring

Form Administration Instructions

The range of values for questions 5 through 10 are all 0 to 3.

Questions 1 through 9 are not allowed to be missing except as noted below. If these questions are missing then any scores calculated using missing questions are also missing. Thus it is important to make sure that all questions 1 through 9 have been answered.

In the event that a range is given for an answer (for example, '30 to 60' is written as the answer to Q2, minutes to fall asleep), split the difference and enter 45.

Reference

Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research* 28:193-213, 1989.

Scores – reportable in publications

On May 20, 2005, on the instruction of Dr. Daniel J. Buysse, the scoring of the PSQI was changed to set the score for Q5J to 0 if either the comment or the value was missing. This may reduce the DISTB score by 1 point and the PSQI Total Score by 1 point.

PSQIDURAT

DURATION OF SLEEP

IF $Q4 \geq 7$, THEN set value to 0
 IF $Q4 < 7$ and ≥ 6 , THEN set value to 1
 IF $Q4 < 6$ and ≥ 5 , THEN set value to 2
 IF $Q4 < 5$, THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDISTB

SLEEP DISTURBANCE

IF $Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j$ (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) = 0, THEN set value to 0

IF $Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j$ (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) ≥ 1 and ≤ 9 , THEN set value to 1

IF $Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j$ (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 9 and ≤ 18 , THEN set value to 2

IF $Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j$ (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 18 , THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQILATEN

SLEEP LATENCY

First, recode Q2 into Q2new thusly:

IF $Q2 \geq 0$ and ≤ 15 , THEN set value of Q2new to 0
 IF $Q2 > 15$ and ≤ 30 , THEN set value of Q2new to 1
 IF $Q2 > 30$ and ≤ 60 , THEN set value of Q2new to 2

IF Q2 > 60, THEN set value of Q2new to 3

Next

IF Q5a + Q2new = 0, THEN set value to 0

IF Q5a + Q2new ≥ 1 and ≤ 2 , THEN set value to 1

IF Q5a + Q2new ≥ 3 and ≤ 4 , THEN set value to 2

IF Q5a + Q2new ≥ 5 and ≤ 6 , THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDAYDYS

DAY DYSFUNCTION DUE TO SLEEPINESS

IF Q8 + Q9 = 0, THEN set value to 0

IF Q8 + Q9 ≥ 1 and ≤ 2 , THEN set value to 1

IF Q8 + Q9 ≥ 3 and ≤ 4 , THEN set value to 2

IF Q8 + Q9 ≥ 5 and ≤ 6 , THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIHSE

SLEEP EFFICIENCY

Diffsec = Difference in seconds between day and time of day Q1 and day Q3

Diffhour = Absolute value of diffsec / 3600

newtib = IF diffhour > 24, then newtib = diffhour - 24

IF diffhour ≤ 24 , THEN newtib = diffhour

(NOTE, THE ABOVE JUST CALCULATES THE HOURS BETWEEN GNT (Q1) AND GMT (Q3))

tmphse = (Q4 / newtib) * 100

IF tmphse ≥ 85 , THEN set value to 0

IF tmphse < 85 and ≥ 75 , THEN set value to 1

IF tmphse < 75 and ≥ 65 , THEN set value to 2

IF tmphse < 65, THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQISLPQUAL

OVERALL SLEEP QUALITY

Q6

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIMEDS

NEED MEDS TO SLEEP

Q7

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQI

TOTAL

DURAT + DISTB + LATEN + DAYDYS + HSE + SLPQUAL + MEDS

Minimum Score = 0 (better); Maximum Score = 21 (worse)

Interpretation: TOTAL ≤ 5 associated with good sleep quality

TOTAL > 5 associated with poor sleep quality

Appendix M: Statement of Non-Research Determination



CNL Project: Statement of Non-Research Determination Form

Student Name: Elisabeth Filiss _____

Title of Project: Improving Firefighter Knowledge of Sleep Science

Brief Description of Project: Sleep impacts all aspects of life, from mental health to physical well-being to job performance. Nowhere is this more important than in the fire service, where extreme working conditions are the norm. Several studies have demonstrated the link between poor sleep and cardiovascular disease (CVD) (Frost et al., 2021 & Ahmad and Didia, 2020). Sleep has also been linked to depression and impulsivity. Cognition and performance decline with sleep deprivation (Khoshakhlagh et al., 2023 & Stout et al., 2021). One-third of firefighters will experience post-traumatic stress disability (PTSD) during their careers (Substance Abuse and Mental Health Services Administration [SAMSA], 2018). Firefighters report poorer sleep metrics than the general population, both on and off duty (Khoshakhlagh et al., 2023 & Stout et al., 2021). However, recent evidence shows that sleep positively affects firefighters' physical and mental well-being (Frost et al., 2021). Changes to the sleeping environment improve firefighters' resting heart rate and blood pressure (Carey et al., 2018). Khoshakhlagh (2023) and Frost (2021) performed literature reviews and recommend sleep education for firefighters.

A) Aim Statement: To improve knowledge of sleep science by 10% over baseline and sleep quality by 25% over baseline by July 2024 in firefighters assigned to Firehouse X

B) Description of Intervention: The intervention will involve presenting firefighters with a comprehensive educational program in sleep science. This program will include evidence-based recommendations for modifying the sleeping environment, adjusting behaviors, and optimizing diet. Firefighters will be guided and supported in implementing these changes to their sleep environments. Regular check-ins will be conducted to encourage and motivate firefighters in their journey toward better sleep.

C) How will this intervention change practice? The intervention is expected to result in significant changes to firefighters' sleep habits and environments. These changes, in turn, are anticipated to lead to improved sleep quality and overall health.

D) Outcome measurements: Sleep knowledge will be assessed by a pre- and post-implementation test. Sleep quality will be assessed by self-reported metrics gathered from quantified self-health and fitness tracker (QSHFT) devices such as Apple Watch, Fitbit, and Oura ring. Participants will be asked to record data from the previous and subsequent months in a journal.



To qualify as an Evidence-based Change in Practice Project, rather than a Research Project, the criteria outlined in federal guidelines will be used:

(<http://answers.hhs.gov/ohrp/categories/1560>)

This project meets the guidelines for an Evidence-based Change in Practice Project as outlined in the Project Checklist (attached). Student may proceed with implementation.

This project involves research with human subjects and must be submitted for IRB approval before project activity can commence.

Comments:

EVIDENCE-BASED CHANGE OF PRACTICE PROJECT CHECKLIST *

Instructions: Answer YES or NO to each of the following statements:

Project Title:	YES	NO
The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.	X	
The specific aim is to improve performance on a specific service or program and is a part of usual care . ALL participants will receive standard of care.	X	
The project is NOT designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control). The project does NOT follow a protocol that overrides clinical decision-making.	X	
The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does NOT develop paradigms or untested methods or new untested standards.	X	
The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does NOT seek to test an intervention that is beyond current science and experience.	X	
The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.	X	
The project has NO funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.	X	
The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., not a personal research project that is dependent upon the voluntary participation of	X	

colleagues, students and/ or patients.		
If there is an intent to, or possibility of publishing your work, you and supervising faculty and the agency oversight committee are comfortable with the following statement in your methods section: <i>"This project was undertaken as an Evidence-based change of practice project at X hospital or agency and as such was not formally supervised by the Institutional Review Board."</i>	X	

ANSWER KEY: If the answer to **ALL** of these items is yes, the project can be considered an Evidence-based activity that does **NOT** meet the definition of research. **IRB review is not required. Keep a copy of this checklist in your files.** If the answer to **ANY** of these questions is **NO**, you must submit for IRB approval.

*Adapted with permission of Elizabeth L. Hohmann, MD, Director and Chair, Partners Human Research Committee, Partners Health System, Boston, MA.

STUDENT NAME (Please print):

Elisabeth Filiss

Signature of Student:

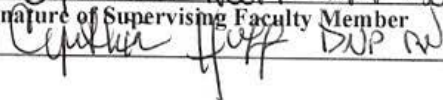


DATE 4/12/2024

SUPERVISING FACULTY MEMBER NAME (Please print):

Cynthia Huff DNP Ed OCN CRA CNE

Signature of Supervising Faculty Member



DATE 4/18/2024

Appendix N: Outcome Data

Firehouse X Results of PSQI Assessments

	51	45	-6	12
	43	32	-11	26
	31	25	-6	19
	33	24	-9	27
	48	47	-1	2
	52	47	-5	10
	37	37	0	0
	27	NA	NA	NA
	29	23	-6	21
	59	40	-19	32
	24	23	-1	4
	28	25	-3	11
	43	37	-6	14
	41	33	-8	20
	38	30	-8	21
	53	NA	NA	NA
	67	59	-8	12
	NA	NA	NA	NA
	42→37	35	6.5	15%