

NORA SYMPOSIUM



Welcome Address

We are delighted by your attendance this year at our Annual NORA Young and New Investigators Symposium. This year commemorates our 22nd Annual NORA Symposium and is attended by students, researchers, and professionals from around the country. We want to thank each of you for attending our symposium and bringing your expertise, knowledge, and vision to our group. We invite you to ask questions of the speakers, network with one another and develop new friendships and collaborations.

We would also like to thank Drs. Ken d'Entremont, Matt Thiese, Joseph Allen for reviewing abstract submissions, and Jessica Gardner-Yates for her efforts in taking care of everything else. Please contact jessicagardner4@weber.edu if you need anything during the symposium. This symposium is made possible in part through the generous support of the Rocky Mountain Center for Occupational and Environmental Health and funding from NIOSH (NIOSH Education and Research Center training grant T42/OH008414-16).

Contents

Day 1: Thursday, April 11 – Morning Session

8:00 – 8:30: Check in and Continental Breakfast
8:30 – 8:45: Welcome and Introduction
8:45 – 9:45: Keynote Speaker NIOSH Extramural Research: Overview and Things to Know as an Applicant and Recipient
Evaluation of Diesel Particulate Matter Exposure Levels at Urban Fire Stations6 10:00 – 10:30, Zach Barrett
Using a Wearable Surface Electromyography Forearm Cuff to Quantify the Frequency and Duration of Repetitive Hand Exertions Among Workers Performing Hand Intensive Jobs
The California Janitor Workload Study: Using Time Motion Methods to Compare Actual Time Spent on Tasks with Industry Standard Time Allotments
Assessing COVID-19 Incidence Between Utah Healthcare Personnel vs. First Responders
12:00 – 13:00: Lunch
13:00 – 13:30: Poster Session Improving Safety Climate Through the Safety Leadership Walk Around: A Systematic Review
Firefighting and Cancer: A Systematic Analysis11 Mubo Olufemi
The Relationship of Air Quality Index (AQI) to Positive COVID-19 Test Count Within the Utah RECOVER Study Population

The Impact of COVID-19 Vaccine Intentions Over Time in Essential Workers [RECOVER] Cohorts <i>Christian Guzman</i>	13
Ground Condition Effects on Ladder Feet Stability <i>Pengshun Tang</i>	14
Job Hazard Analysis for a Utah Printing Company Nathaniel Baxter	15
Assessing COVID-19 Incidence Between Utah Healthcare Personnel vs. First Responders Naveen Naveed	9

Thursday, April 11 – Afternoon Session

Assessing the Impact of Unionization on the Relationship Between Workload and Health Among California Janitors16 13:30 – 14:00, K. Ru
Powered Knee Exoskeleton Designed for Warehouse Workers in Mind
14:30 – 14:45: Break
Fitness Differences Between Graduates and Released Firefighter Academy Recruits
Exploring the Applicability of Critical Intensity in Firefighters: A Case Study19 15:15 – 15:45, Benjamin Mendelson
Cardiovascular Risk Factors and Low Back Pain Among Manual Material Handlers: A Prospective Cohort Study20 15:45 – 16:15, Jenny Echeverria
Meaningful Change21 16:15 – 16:45, Josh Griffin

Day 2: Friday, April 12 – Ergonomics and Mental Health

8:00 – 8:30: Continental Breakfast
8:30 – 8:45: Recap of Day 1
8:45 – 9:45: Richards Lecture Speaker Economic Factors Driving Occupational Health and Safety: Evidence from the Trucking Industry
Burnout Associations Using Job Demands and Resources Model Among Lawyers23 10:00 – 10:30, Jacob Overfelt
Analysis of Vicarious Trauma and mental health outcomes in Lawyers
A Motorized Ankle Orthosis for Occupational Injury Prevention25 <i>11:00 –11:30, Kai Pruyn</i>
Relationship Between Heart Rate Variability and Recovery Activities Utilized by Career Firefighters
Ergonomic Evaluation of Fine-Paper Collation Process of Printing Press27 <i>12:00 – 12:30, Katrina Cernucan</i>

12:30 – 13:30: Lunch and Conclusion

Lunch, conference discussion, wrap up, and presentation of the BLOHSWEIC Prize awards.

Keynote Speaker

Dawn Castillo

Dawn Castillo is the Director of the Office of Extramural Coordination & Special Projects (OECSP) at the National Institute for Occupational Safety and Health (NIOSH). In this role she provides oversight to the NIOSH extramural portfolio of approximately 150 grants and cooperative agreements for research and workforce development.

Ms. Castillo began her NIOSH career in 1991 as an epidemiologist in the Division of Safety Research (DSR). She held various roles in DSR up until June 2023. She was Chief of the Surveillance and Field Investigations Branch between 1998 and June 2011, and Division Director from July 2011 to June 2023. During her tenure as DSR Director, Ms. Castillo managed several cross-institute programs: Traumatic Injury Prevention; Transportation, Warehousing and Utilities Program; Center for Motor Vehicle Safety; and Center for Occupational Robotics Research. Ms. Castillo was appointed OECSP Director in July 2023. She was the fourth recipient, in 2000, of the James. P. Keogh award, an annual NIOSH award recognizing a current or former NIOSH employee for exceptional service to the field of occupational safety and health. The Keogh award recognized her work to protect youth workers.

Ms. Castillo has authored numerous articles, book chapters, and technical documents on a variety of occupational injury topics, including occupational injuries among young workers, older workers, and fire fighters; workplace violence; and occupational robotics safety and health. Ms. Castillo received her B.S. in Biology from the University of California, Irvine and her Master's of Public Health in epidemiology from the University of California, Los Angeles.

Evaluation of Diesel Particulate Matter Exposure Levels at Urban Fire Stations

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Introduction: Firefighters often face high exposure to diesel particulate matter (DPM)_a when compared to the general population from idling diesel vehicles and frequent engine operation [1]. These elevated levels of DPM pose potential acute and long-term health concerns for firefighters, including irritation of the nose and eyes, headache, fatigue, nausea, decreased lung function, cough, sputum production, and even lung cancer [2-6]. These risks are accentuated by 10-to-20-year engines, older exhaust-emissions standards, and lack of adequate ventilation or filtration systems in older stations, making it challenging to control exposure [7]. Robust and specific data regarding DPM levels in fire stations is lacking. This study compares DPM levels in a 58-year-old station and a 14-year-old station_using three sampling locations during engine run: the engine bay, the engine cab, and the firefighter living quarters at each station.

Methods: Particulate matter samples were taken weekly, on the same day, from each station during mock or actual "Turnout" calls where firefighters donned their clothing and equipment using a Grimm Model 1.109 (figure 1) direct-reading aerosol spectrometer, a validated DPM measurement tool. The Grimm Model 1.109 can collect particle count data from 0.25 μ m to 32 μ m. The size fraction of interest for DPM is 0.25 - 1 μ m. Instrument readings were monitored for peak DPM levels at each site for one minute after each of the three samples. Six separate visits for each station will be completed, and peak DPM levels will be collected and compared between the stations at each collection site.

Results: Preliminary results show that the older fire station showed higher DPM levels at all collection sites. This is likely due to the station's smaller bay space, less robust filtration, and older trucks which may produce greater DPM emissions. The DPM concentration inside the engine cab was less than half that of the bay and the DPM levels inside the living quarters were ¹/_s that of inside the garage. The newer station shows six-times less accumulation of DPM than the older station. Within the new station, DPM inside the cab was the same as the bay, while DPM in the living quarters was less than ¹/₃ that of the bay. Upon completion of data collection, statistical analysis using a t-test using Microsoft Excel will be used to make station and location-specific DPM concentration comparisons.

Conclusions: We anticipate that the older station with a smaller bay, older engines, and a less robust filtration system will have statistically significantly higher DPM levels in its bay, cab, and living quarters. This data will help increase awareness of fire-station differences as they pertain to DPM exposure and facilitate changes in either engineering or administrative controls to mitigate firefighter risk. Based on our results, recommendations for potential DPM control measures will be presented to the fire stations.





Using a wearable surface electromyography forearm cuff to quantify the frequency and duration of repetitive hand exertions among workers performing hand intensive jobs.

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Introduction: Previous epidemiological studies have shown an exposure response relationship between repetitive forceful exertions and MSDs of the upper extremity. Sustained or repetitive non-neutral postures have also been shown to increase risk of upper extremity MSDs. However, prior studies used time intensive methodologies to quantify biomechanical exposure and risk of MSDs that included direct measurements and detailed video analysis, particularly to quantify hand activity levels. Wearable technologies may provide a more efficient approach to quantifying the frequency and duration of hand exertions. Therefore, the purpose of this pilot study was to compare the accuracy of hand activity level measurements from wearable monitors to the gold standard video analysis approach using different analytical approaches.

Methods: This study is part of a larger study evaluating the impact of poultry processing line speed on worker health. Surface electromyographic data was collected at 500 Hz using an 8-channel forearm cuff (Mindrove, Budapest, HU). Maximum voluntary contractions were collected using a variety of maneuvers and a Biometrics electrogoniometer (Biometrics Ltd., Gwent, UK) at 1000 Hz for wrist posture. Video was collected from the side and overhead at 30 frames per second and analyzed using Multimedia Video Task Analysis (MVTA). Ten minutes of data was collected while workers performed their typical work. Five minutes of the video was analyzed frame by frame to quantify the frequency and duration of hand exertions. EMG data from the eight channels was processed. At each time point, data from all eight channels was summed and divided by the sum of the maximum muscle activity of all eight channels to provide an 8-channel cumulative %MVCThree thresholds (5%MVC, 10%MVC, and 20%MVC) were applied to the EMG data, with window sizes set at 0.5 sec, 1 sec, and 2 sec to extract the frequency and duration of exertions. The outcomes for exertions above these thresholds were then compared with the metrics derived from MVTA.

%MVC / Window Size	0.5 s	1 s	2 s
5 %	0.504 Hz	0.259 Hz	0.142 Hz
10 %	1.504 Hz	0.767 Hz	0.407 Hz
20 %	0.399 Hz	0.309 Hz	0.319 Hz

Results: Duty cycles for 5%, 10%, and 20% MVC were 94.03%, 89.99%, and 64.47%, respectively.

Conclusions: This analysis explores how thresholds and window size impact the estimated frequency and duty cycle estimated from an 8-channel EMG wearable arm cuff. Additional analysis is underway.

The California Janitor Workload Study: Using Time Motion Methods to Compare Actual Time Spent on Tasks with Industry Standard Time Allotments.

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Introduction: Janitors are essential workers yet are some of the most vulnerable workers in the service industry. Previous studies have reported on the high workloads and prevalence of pain and injury among janitors. Janitorial companies use the International Sanitary Supply Association (ISSA) Clean Standards (2021) to allocate time to clean different areas. However, the accuracy of such time allotments has been shown to vary in office venues and has not been evaluated in other types of venues. Further, the COVID-19 pandemic impacted both disinfection requirements and the use of venues cleaned by janitors which may impact time required to clean different spaces. Misallocation of time allocated to janitors to clean spaces could contribute to high workloads. Therefore, as part of a larger study on the workload of California janitors, we describe here a methodology to compare ISSA allocated time on task with actual time spent cleaning different spaces at different types of venues.

Methods: Janitors were video recorded at 30 frames per second for up to 4 hours of work. Direct measurements of loads, distances, and tool weights were collected separately. Video was analyzed frame by frame using Multimedia-Video Task Analysis (MVTA) software (NexGen, Inc, University of Wisconsin, IL). Videos were coded to tag the location of the work (e.g., restrooms, common spaces, elevators), the type of task (e.g., disinfecting, trashing, resupply), and the tools used (e.g., rags, spray bottles, mops) in the janitor's dominant hand. The location and task data were used to estimate the time allocated for cleaning using the ISSA Clean Standard (2021 International Sanitary Supply Association) and compared to the actual time spent. A ratio was calculated comparing the expected time allocated for tasks according to ISSA standards to the actual time spent on tasks. The absolute percent deviation was calculated.

Results: Three janitors on average, spend 33% of their time in common spaces, 19% in bathroom, 14% in cafeteria, 12% in office. The common tasks performed are disinfecting (18%), transport (17%), trashing (13%), and vacuum cleaning (7%). 6% of their time in shifts were on break. The average percent deviation was 44% (SD = 0.28) of all spaces and tasks combined. Within these deviations, the magnitude of variation from ISSA standards was such that in some instances janitors spent 48% more time than the standards suggest (SD=0.15), while at other times they spent 49% less time (SD=0.10). For example, actual times for common space cleaning can exceeded ISSA standards by 59% (SD=0.09) in some instances, whereas they were 29% less in others (SD=0.55). Bathroom cleaning times were 38% longer than standards (SD=0.08), and in some cases, they were 41% shorter than the standards. For disinfecting/scrubbing, janitors spent an average of 57% more time than ISSA standards suggest (SD=0.11), while for trashing tasks, janitors spend 50% less time (SD=0.02). Transport tasks can take 53% more time (SD=0.64), or in some cases where janitors spend 62% less time than the standard. Based on an 8-hour day shift, the janitors would have been expected to deviate from ISSA standards by spending 20.97 minutes less, or up to 47.91 minutes more on tasks than the standard anticipate.

Conclusions: Our findings suggest that the observed pace is different from the expected productivity rate by ISSA standard in both directions, as certain tasks and spaces are consistently overestimated or underestimated. It is important to notice tasks where janitors spend more time than the standards account for. Future cleaning standards should aim to establish accurate time allocations that not only reflect actual work patterns but also consider biomechanical risks. Ongoing analysis will compare allocated versus actual time spent cleaning across different spaces at different venues to guide changes in how janitorial workload is allocated.

Acknowledgement: This study was supported by the California Commission on Health and Safety and Workers Compensation and a Training Grant, T42OH008429, funded by the National Institute for Occupational Safety and Health (NIOSH) / Centers for Disease Control and Prevention (CDC).

Assessing COVID-19 Incidence Between Utah Healthcare Personnel vs. First Responders

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Introduction: The COVID-19 pandemic has highlighted the elevated risks faced by essential workers, particularly healthcare personnel (HCP) and first responders (FR). (Gaitens, et al.) While some studies suggest HCPs have a higher risk of contracting the virus due to direct patient exposure (Nguyen et al.) others indicate that first responders may be at greater risk (Ellingson et al.). We aim to analyze the incidence of COVID-19 in HCP and FR through a long-term, multi-site study at the Utah site of the Research on the Epidemiology of the SARS-CoV-2 in Essential Response Personnel (RECOVER) study. Based on the results of (Nguyen et al.), we hypothesize that HCP may be at higher odds of contracting COVID-19 compared to FR due to their increased direct patient exposure.

Methods: A prospective cohort study was conducted on Primary & Other Allied HCP and FR. Within the RECOVER study HCP was defined as anyone who works in a healthcare setting or a health-related occupation. FR were defined as people working in emergency response, EMT, paramedic, law enforcement, fire services and others. We analyzed data of 592 participants from the RECOVER study between October 2020 till May 2023. We excluded 4 participants as they did not perform any COVID tests. Demographic data, employment data and self-reported weekly working hours in direct patient contact were collected from enrollment and multiple follow-up surveys. Participants self-collect weekly nasal swabs (with or without symptoms) which were tested through reverse transcription-polymerase chain reaction (RT-PCR) for SARS-CoV-2 infection. Incidence rates were calculated by taking the total number of positives over the duration of the study in each respective category (HCP and FR). The number of positive tests per 1000 person-weeks was then calculated for each category. Individuals were deemed fully immunized if they had received a second dose of the mRNA COVID-19 vaccine and unvaccinated participants had no COVID-19 vaccine receipt. (Naleway, et al)

Results: The analytic population resulted in 124 FR and 468 HCP. Majority of the HCP were female 351 (75%), whereas majority of FR were male 83 (67%). Percentage of FR and HCP fully vaccinated was 66.4% (SD:4.96) and 70.9% (SD:8.99), respectively. The average weekly hours spent in direct patient contact by FR and HCP were 24.7 and 30.5, respectively. The incidence rates for FR and HCP were 59.6 and 26.8 positive tests per 1000 person-weeks, respectively.

Conclusions: Contrary to the hypothesis, there may be an increased susceptibility of FR to COVID-19 compared to HCP. It emphasizes the need for targeted interventions and enhanced protective measures to ensure their safety. More research is needed to understand the drivers leading to this difference so we can be better prepared for the next pandemic.

Improving Safety Climate Through the Safety Leadership Walk Around: A Systematic Review

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Introduction: Safety climate refers to shared perceptions, attitudes, beliefs, and values related to safety within an organization. These components are distinct from the broader concept of safety culture. A positive safety climate is crucial for promoting safe behaviors, reducing accidents, and ensuring employee well-being. Organizations fostering a positive safety climate typically experience fewer incidents, higher productivity, and greater employee satisfaction. Safety climate is closely linked to worker engagement in safety behaviors and is predictive of both organizational and safety outcomes. Continuous assessment, open communication, and active leadership involvement are key to developing and sustaining a positive safety climate. The Safety Leadership Walk Around (SLWA) is a proactive approach used in various industries to promote and assess safety practices within an organization, especially in high-risk environments. The SLWA involves leaders physically walking around the workplace, interacting with employees, and discussing potential hazards. The primary objective of this study was to conduct a literature review and explore the effectiveness of interventions, such as the SLWA, in improving safety climate within organizations and to identify steps and best practices for implementing such strategies.

Methods: This systematic review was conducted following the PRISMA-P checklist. Peer-reviewed articles from academia and industry are included in this review to capture the practical usage of the SLWA-type safety meeting. Five databases (Scopus, CINHAL, Web of Science, PubMed, and Google Scholar) were utilized systematically and iteratively to collect manuscripts from peer-reviewed and industrial trade journals, using Safety Leadership Walk Around specific terminology. All literature relating to some form of managing by walking around was considered. Articles were excluded if (1) they did not discuss a Managing by Wandering/Walking Around intervention, (2) were published in a non-English language, (3) full-text versions were unavailable, and (4) did not look at safety climate as a primary or secondary outcome.

Results: Results from the studies indicated a significant relationship between managing by walking around interventions, such as SLWA, and safety climate in nearly all cases. Cross-sectional studies and a prospective cohort study found a positive impact on safety climate scores. The study in a Chinese petrochemical corporation reported significant changes in safety climate, safety motivation, burnout, and safety behavior after participating in a safety management by walking around (SMBWA) intervention. A randomized control trial found no mean difference but higher safety climate scores for participants in the intervention. Pre-post case studies showed mixed results, with some indicating consistent safety climate scores and others showing a decrease after the intervention.

Conclusions: The collective findings indicate managing by walking around interventions like the SLWA can be used as a communication-based intervention to improve safety climate. This intervention could be used in high reliability organizations to advance safety climate. However, the need for supervisors and managerial buy-in is high. Some studies noted challenges in participation due to management commitment requirements. Theoretical implications include considering these interventions as resources to mitigate job demands, using the job demands-resources model.

Firefighting and Cancer: A Systematic Analysis

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Introduction: Firefighters are exposed to various carcinogenic hazards during their duties, leading to significant concerns about their risk of developing cancer. Exposure to harmful substances like benzene, polycyclic aromatic hydrocarbons (PAHs), formaldehyde, and sulfur dioxide during firefighting activities poses substantial risks, primarily through inhalation, accidental ingestion, and dermal absorption. Some studies have linked firefighting to increased risks of cancers such as mesothelioma, bladder cancer, and others, attributable to occupational exposures. However, variations in research outcomes exist due to diverse occupational settings, regulations, and protective measures across regions. Given firefighters' vital role in society, it is crucial to understand and address these risks comprehensively. Thus, this study aims to thoroughly review existing literature to explore the association between firefighting and cancer risks.

Methods: A systematic literature review encompassed 41 peer-reviewed original articles from various countries. Articles were included if they had fully accessible text and reported an associated risk measure. Exclusions were made for studies involving military veterans turned firefighters, volunteers, and firefighters exposed during the World Trade Center incident due to concerns about distinct exposures and potential bias.

Results: While overall standardized incidence ratios for all cancers did not significantly differ from the general population, specific cancers like mesothelioma (SIR:2.59, 95% CI 1.12-5.11), bladder (SIR: 1.14, 95% CI 1.04–1.23), colon (SIR:1.14, 95% CI 1.06-1.21), and testicular cancers (SIR:11.9, 95% CI 1.44-42.9) showed significant associations. Studies also highlighted increased risks with prolonged employment duration, particularly for colon and prostate cancers. Regional variations were noted, with European studies indicating excess incidence in prostate, respiratory, and skin cancers, while North American studies reported increased risks in brain, lung, colon, testicular, bladder, and Hodgkin's lymphoma. Occupational exposure was linked to gastrointestinal, genitourinary, and skin cancers, with consistent findings across multiple studies.

Conclusions: Positive correlations between firefighting and various cancer sites were observed across multiple studies. A prospective assessment of cancer incidence and mortality may enhance our understanding of firefighters' cancer risks, considering the complexity of occupational exposures and challenges in interpreting cancer risk dat.

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The Relationship of Air Quality Index (AQI) to Positive COVID-19 Test Count Within the Utah RECOVER Study Population

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Introduction: Air pollution poses a significant burden to human health, contributing in up to 8000 premature deaths per year in Utah (Errigo, et al.). Additionally, previous studies show a positive pearson correlation coefficient between air pollution and Influenza Like Illnesses of 0.36 (Tang, et al.). However, it remains unclear if elevated Air Quality Index, a measurement of overall air quality, has a similar effect on COVID-19 transmission within the RECOVER Study population. In this analysis, we aimed to determine whether there is a relationship between the number of COVID-19 infections and AQI at the county level.

Methods: We analysed the data of 574 workers from the RECOVER study, a multisite prospective cohort study of Healthcare Workers, First Responders and Essential Workers. Demographic information was collected from enrollment and follow-up surveys. Infection data was obtained from weekly reverse transcription-polymerase chain reaction (RT-PCR) testing for instances of 1 COVID-19 infection or multiple (≥ 2). Using their respective zip codes, participant data was sorted by county. Counties with less than 50 participants were omitted. Counties included in our analysis are as follows: Utah County with 55 participants, Salt Lake County with 438 participants and Davis County with 81 participants. Positive tests were sorted by date and matched to the EPA's (Environmental Protection Agency) historic AQI (Air Quality Index) data for the respective county and timeframe. Each dataset was bound to the largest stable period of total enrolment (June 1, 2021, to February 28, 2022). Positive test data was averaged over 7-day periods to minimize the effect of the varying daily total test count, and the AQI was averaged over the same 7-day periods to match. In this linear correlation analysis (June 1, 2021, to February 28, 2022), we calculated the PCC (Pearson Correlation Coefficient) between the average weekly AQI value and the average weekly positive COVID-19 tests for each county group to examine the correlation between AQI and the positive test count. PCC was calculated both concurrently and by delaying the test results one week to check for a delayed correlation between AQI average and the next week's positive test average.

Results: Positive COVID-19 test data and AQI showed no significant correlation in concurrent or week delayed calculations for any county. The PCC for each county is as follows: Salt Lake County concurrent r = -0.010, Salt Lake County delayed r = -0.026, Davis County concurrent r = 0.120, Davis County delayed r = 0.017, Utah County concurrent r = -0.063, Utah County delayed r = -0.026.

Conclusions: Within our study, AQI and Positive Covid Tests have no significant correlation for RECOVER participants in Salt Lake County, Davis County and Utah County from June 1, 2021, to February 28, 2022. These results suggest that factors such as age, occupation, health status, circulating variant, community exposure, and/or vaccination status may play a role in AQI's effect on the rate of COVID-19 infections. This does not prove that there is no correlation between AQI and the rate of COVID-19 infections. Further testing with larger datasets and taking more control over confounders into account is needed for future studies.

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The Impact of COVID-19 Vaccine Intentions Over Time in Essential Workers [RECOVER] Cohorts.

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Introduction: May 11, 2023 marked the end of the federal COVID-19 public health emergency (PHE). However, COVID-19 is considered to be in its pandemic phase because the number of infections continues to increase worldwide (End of the federal COVID-19 public health emergency (PHE) declaration 2023). Like the 1918 influenza pandemic, as we transition from a worldwide pandemic to an epidemic or seasonal endemic, it is important that we consider human intentions on COVID-19 vaccines over time (Covid endemic vs pandemic - is it here to stay? 2024). Our objective is to determine how COVID-19 vaccine intentions change over time categorized by variant type.

Methods: In a cohort study RECOVER, participants were followed from July 2020 to April 2023. Vaccine intentions were accessed using participants' first response to the question, "What are the chances that you will get a COVID-19 vaccination?" and vaccination status at the time of Follow-up survey (Lutrick et al., 2022). To follow vaccine intentions over time, follow-up survey responses were gathered at three-month intervals. Each response was rated on a Likert scale of 7 allowing participants to rate their intentions with a negative or positive response to COVID-19 vaccines. Participants were required to report vaccine information upon enrollment. Vaccination was verified by participant-provided vaccination cards information upon enrollment.

Results: From July 2020 to May 2023 responses from 963 participants who completed follow-up survey 1 at enrollment and follow-up survey 9 were included into the analysis. We descriptively examined vaccine intentions over time through a logistic regression test. Odds Ratios (OR), and p-values were calculated using Statistical Analysis System (SAS) software indicating.

Conclusions: Perceptions of the COVID-19 vaccine can shift over time. As these perceptions change, researchers have been able to identify the underlying variables that can create the growth of positive perception changes, therefore, promoting the positive shift through vaccination campaigns (Akarsu et al., 2020). It will be hard to predict the path COVID-19 will take to become endemic, therefore the importance of taking control measures to reduce transmission until enough people have been vaccinated to achieve herd immunity or to drastically reduce the severity of infections, otherwise the darkest days of the pandemic are still ahead of us (Phillips et al., 2021).

Ground Condition Effects on Ladder Feet Stability

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Introduction: Unstable ladders result in fatal and non-fatal injuries. Annually, there are 500,000 medical treatment cases related to ladders in the US¹. 300 of these cases result in a fatality¹. Nearly a quarter of ladder related fatalities have been attributed to lost stability of the ladder². The stability of ladder is directly affected by the friction at the ladder's feet. The available friction between the ladder feet and ground can be quantified, referred to as the available coefficient of friction (ACOF). Ladders are used across various ground conditions, from smooth to rugged, soft to solid, indoor to outdoor. There is a need to understanding the ACOF of the ladder feet across various ground conditions, as conditions with lower ACOF will increase ladder slip risk. This pilot study assesses the ACOF across three ladder feet designs and three ground conditions. We hypothesized that the ACOF of a name-brand ladder foot would be greater than the ACOF of generic ladder feet and the ACOF to vary across ground conditions.

Methods: A mechanical pulley system was utilized to assess the ACOF between three different ladder feet designs (Figure 1: A – name-brand, B – generic, C – generic) across three ground conditions (wood, tile, concrete). The pulley system comprised of Flexinol[®] Actuator wire in-line with a frictionless bearing and Mark-10 M5-200 force gauge (0.2 N resolution) for precise force measurement. The peak force recorded by the force gauge was modeled as the frictional force between the ladder feet and ground prior to ladder foot slip. Each ladder foot sample was tested five times per ground condition. Force data was collected continuously in NI LabVIEW software. The frictional force (peak force recorded) was extracted for each trial and divided by the normal force of the ladder foot sample to quantify the ACOF. Each foot sample was loaded to the same mass (400g). An ANOVA test was performed on the ACOF with ladder foot sample and ground condition as predictor variables to test our hypothesis. Trial number was added to the model as a covariate. If a significant difference was found, a Fisher's LSD post-hoc test was performed to determine which groups differed.



Figure 1: Types of ladder feet.

Results: The average (standard deviation) ACOF across each ladder foot, regardless of ground condition was 0.863 (0.067), 0.862 (0.086), 0.785 (0.061), for foot type A, B, and C, respectively. The average (standard deviation) ACOF across ground conditions was 0.736 (0.016), 0.579 (0.012), and 1.195 (0.03) for Wood, Tile, and Concrete, respectively. Ground condition had a significant effect on ACOF ($F_{2,42}$ =198.0, p<0.001), but not ladder foot type ($F_{2,42}$ =2.1, p=0.142). Concrete had greater ACOF than wood and tile (LSD post-hoc: p<0.001), and wood had a greater ACOF than tile (LSD post-hoc: p=0.012).

Conclusions: The ACOF was strongly affected by the ground condition. Concrete had the greatest ACOF among our tested surface types. We did not find foot type to affect the ACOF, but the loads used in this pilot study were low (only 400g). Future work should conduct testing with loads reflective of human/ladder weight. This knowledge is important for improved design of ladder feet, ladder safety attachments, and policy to reduce ladder falls.

Job Hazard Analysis for a Utah Printing Company

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Introduction: A Job Hazard Analysis (JHA) is a technique that focuses on job tasks as a way to identify hazards before they occur. JHAs look at the relationship between the worker, the task, the tools, and the work environment. (OSHA 3071). The operation of interest is a printing facility that serves as the primary production site the organization uses for a wide array of products for consumers worldwide. Documented hazards in the printing industry include broken bones, toe amputations, hand lacerations, slip/trip/fall related injuries, and exposure to chemicals such as volatile organic compounds (VOCs)¹. With products ranging from magazines and small pamphlets to stitch-bound books, the print facility employs approximately 240 workers and utilizes many machines and processes to ensure the necessary volume of products can be produced in a timely manner and at their high-quality standard. The process of interest is the operation of the presses used for printing magazines.

Methods: A job hazard analysis (JHA) involves systematically identifying potential hazards associated with a particular job or task and determining the appropriate controls to mitigate those hazards. Steps include selecting a task, breaking the task down into steps, identifying and considering the potential consequences of hazards, identifying and evaluating the effectiveness of existing controls, documenting and reviewing findings with leadership, training, and monitoring. The black-and-white printing press and the color printing press operations were specifically selected by the printing operation's Safety, Health & Environmental Coordinator for evaluation by JHA due to the potential to cause OSHA recordable injuries due such as lacerations or slip/trip/fall injuries².Each of the printing-press workers on duty was observed and selected workers were interviewed to define the steps associated with each task. Photos and videos were taken for reference.

Results: Recommended potential controls for the mentioned hazards include a restraint applied to the lift mechanism of the paper roll to reduce the pendulum motion. This control should only minimally influence the time it takes to complete the task; however, it does greatly lessen the risk for an injury. The second recommendation is an ergonomic solution to carrying large, awkward metal printing plates to prevent slips, trips, and falls and gloves to prevent hand lacerations during the carry. These recommendations will be presented to the company's Safety, Health & Environment Coordinator for review and potential implementation.

Conclusions: In conclusion, a Job Hazard Analysis was conducted to identify job hazards, a number of which may not be obvious without a rigorous method to understand the interaction between worker, task, tools and work environment. A JHA was conducted at a local printing press according to OSHA 3071 guidance, during which two major hazards, loading the paper roll and carrying the metal sheets, were identified, along with other minor hazards. Controls have been identified and will be presented to the company's health and safety leadership team in order to work towards implementation.

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Assessing the impact of unionization on the relationship between workload and health among California Janitors

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Introduction: In California (CA), the union that represents janitors, Service Employees International Union (SEIU), and a nationally recognized state watchdog, the Maintenance Cooperation Trust Fund (MCTF), has raised concerns about the increased workload and resulting injuries reported by their members. Prior analyses of our CA Janitor Workload Study corroborated this and found positive associations between high workload and adverse physical and mental health outcomes. Yet, there is limited insight on the impact of unionization which this study sought to quantify. Resurgences in collective action among workers across the country underscores the importance and timeliness of this analysis.

Methods: We conducted a cross-sectional survey in 2022 of CA janitors from the SEIU and MCTF. Physical workload exposure was assessed via self-reported measures across 16 common tasks, accounting for intensity, frequency, and duration to calculate an overall workload index score. These scores were then categorized into low, medium, and high workload groups. Prevalence of severe pain was self-reported using the 10-point numeric pain scale across 4 body regions while prevalence of anxiety/depression was determined using the PHQ-9 and GAD-7 surveys respectively. Logistic regression was used to estimate odds ratios (ORs), adjusted for age, sex and total years worked as a janitor. To assess whether union status was an effect modifier in the exposure-outcome relationship, stratified analyses were conducted, and union status was included as an interaction term in our models to assess for significance.

Results: 403 participants answered the relevant survey questions, including 146 (36%) union and 257 (64%) nonunion janitors. Approximately 17% of union and non-union workers reported anxiety/depression. For severe pain, 40% of union and 47% of non-union workers reported severe pain. The OR for severe pain and high workload index was 8.14 [95% CI: 3.9, 17.1] and 17.96 [95% CI: 1.6, 56.8] for unionized and non-union workers, respectively. For anxiety/depression, the OR in the high workload index groups was 2.05-fold [95% CI: 0.8, 5.2] and 2.51-fold [0.6, 9.5], union and non-union respectively.

Conclusions: Non-union janitors reported higher odds ratios for severe pain prevalence compared to union workers, supporting prior literature on protective effects of unionization and collective bargaining in other occupations. In contrast, both union and non-union janitors reported similar odds ratios for depression/anxiety, suggestive of the mental burden workers face regardless of union status in the study population. Though results were not significant, they highlighted the precarious nature of janitorial work and the need for further studies to fully understand these associations and identify areas for intervention and protection among janitors in California.

Powered Knee Exoskeleton Designed for Warehouse Workers in Mind

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Introduction: Individuals working in logistics and warehouse management are at an elevated risk for lower extremity injuries. In 2020 alone, 66,650 individuals suffered a knee injury while working in a warehouse. One of the most common places where these injuries occur is during manual material handling and material storage (racking) [1]. Although lower-back injury rate may be decreased by using proper lifting form, reducing muscle fatigue and knee joint load with assistive technologies is also necessary.

Powered exoskeletons are a promising solution to reduce knee injuries during manual material handling. Typical warehouse tasks place a wide range of speed and torque demands on the knee. Tasks such as walking require high speed and low torque, while tasks such as squatting require low speed and high torque. Traditional powered exoskeletons with fixed transmission ratios must either use large, heavy motors to achieve this range of requirements or accept reduced performance in exchange for reduced weight. To address this open issue, we have developed a knee exoskeleton with a unique actuation system that allows for a lightweight design without sacrificing torque and speed.

Methods: The powered knee exoskeleton uses a torque-sensitive joint to optimize its transmission ratio. The

actuator system uses a ball screw in the main drive train that connects to a five-bar linkage. A spring-loaded joint alters the length of one of the links in response to high torques and high flexion angles. The change in link length effectively alters the transmission ratio passively and continuously. Overall, this actuation design allows a small motor to achieve a wide range of speed and torque requirements and results in a lightweight yet powerful exoskeleton.

We verified the torque capability of the device through benchtop testing. To test the feasibility of warehouse tasks, we developed a virtual spring controller for squatting tasks. One healthy subject wore the exoskeleton and completed standard squats with a small handheld load and reach to simulate manual material handling. The exoskeleton provided assistance during the extension phase of the squat.

Results: The powered knee exoskeletons with battery weighs 1484 g. Similar commercial exoskeletons marketed towards warehouse workers weigh 3175 g. From the benchtop testing, we determined that the knee exoskeletons could provide 55 Nm of peak torque.

Conclusions: This work demonstrates that a powered knee exoskeleton



Figure 1. Powered Knee Exoskeleton

with a torque-sensitive actuator can satisfy the basic requirements to assist individuals working in logistics and warehouse management. The proposed powered knee exoskeleton can offset approximately 1/3 of the knee effort during a deep squat, which requires 150 Nm of torque for the 50th percentile man [2]. Its lightweight and compact design improves comfort and allows for unrestricted movements during common warehouse tasks. Further research should focus on quantifying improvements via motion capture and reduction in muscle activity via EMG.

Fitness Differences Between Graduates and Released Firefighter Academy Recruits

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Introduction: A firefighter (FF) recruit academy involves a rigorous training period lasting several weeks to months. The purpose of a fire recruit academy is to prepare trainees for their impending assignment within the department as probationary FFs and eventually non-probationary active-duty members. Most often, fire academies are designed to fill vacant positions due to retirements, employee departures, or growth in the department. Thus, retention of recruits is vital to the department's ability to meet call volume demands and manage the overall workload placed on employees (i.e., minimize high amounts of overtime and mandatory work days). The intense physical, mental, and technical challenges that recruits face may lead to their release from the academy due to voluntary resignation, injury, or failure to complete academic or skill-related training requirements. To date, there is an absence of literature exploring the physical fitness differences between FF recruits who graduate (GRAD) versus those who are released (REL). Given that FF recruits are the fire department's investment, success of these recruits is imperative to sustain an operationally successful department. Thus, the purpose of this study was to explore the initial fitness differences between FF recruits who graduated and were released from the academy.

Methods: Fitness data were collected from 12 separate FF academy recruit cohorts (2012-2019, 2021-2023) resulting in a total of 382 recruits (GRAD: n = 343, 26.2 ± 7.1 yrs, 177.7 ± 8.0 cm; REL: n = 39, 33.4 ± 7.5 yrs, 176.6 ± 10.1 cm). In the first week of the academy, recruits completed a battery of assessments including: *body composition* estimated by measuring body mass (BM, kg) and estimating percent body fat (PBF, %) via skinfold measures; *movement quality* via movement efficiency screen (MES, 0-100); *muscular strength* from the sum of right and left handgrip (SHG, kg) and normalized to BM (kg/BM_{kg}); *muscular endurance* from the total number of push-ups completed during a paced 2-minute test (PU); and *aerobic fitness* (\dot{VO}_{2peak} , mL/kg/min) and heart rate recovery (HRR_{1min}, %) relative to age-estimated maximum heart rate estimated from the 5-minute Forestry Step Test. Differences in initial physical fitness among FF recruits who graduated and were released were examined via independent *t*-tests for normally distributed data (SHG, HRR_{1min}) and Wilcoxon Rank Sum tests for non-normally distributed data (BM, PBF, MES, PU, and \dot{VO}_{2peak}). An alpha of 0.05 determined statistical significance.

Results: Compared to the GRADs, the RELs had significantly higher BM ([mean \pm SD], 93.6 \pm 18.7 vs. 86.9 \pm 16.2 kg, z = 2.08, P = 0.037), PBF (22.2 \pm 7.1 vs. 17.1 \pm 6.3 %, z = 4.18, P < 0.001) and significantly lower MES (54.0 \pm 15.1 vs. 64.2 \pm 13.6, z = -3.44, P = 0.001), PU (25.7 \pm 12.2 vs. 31.0 \pm 11.3, z = -3.03, P = 0.002), \dot{VO}_{2peak} (37.7 \pm 6.5 vs. 43.2 \pm 11.4 mL/kg/min, z = -3.36, P = 0.001), and HRR_{1min} (18.6 \pm 4.7 vs. 21.4 \pm 6.0 %, $t_{36} = -2.96$, P = 0.006). There was a non-significant difference in SHG (1.09 \pm 0.2 vs. 1.13 \pm 0.3 kg/BM_{kg}, $t_{52} = -1.22$, P = 0.227).

Conclusions: Though recruits enter the FF recruit academy with similar muscular strength, released recruits have higher body fat and lower movement quality, muscular endurance, and aerobic fitness at academy onset compared to recruits that graduated. These data suggest that fire department recruitment and retention initiatives should consider adjustments to their training programming which emphasize these disparities in fitness to promote graduation from the fire academy. Further, given the operational impact of unfilled vacancies due to released recruits, fire departments should consider implementing fitness screening that assesses body composition, movement quality, and aerobic fitness during the academy admission process and/or developing a pre-academy fitness program to address these fitness characteristics. As reasons for release from FF recruit academy extend beyond physical characteristics, future work should investigate the involvement of psychosocial and/or technical characteristics in released recruits.

Exploring the Applicability of Critical Intensity in Firefighters: A Case Study

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Introduction: Recent work has indicated that heart rate (HR) intensity while completing simulated fireground tasks (SFGT) may be better understood by measuring time spent in specific intensity zones. One that has garnered interest is time spent above or below the HR at the Respiratory Compensation Point (HRRCP), a value that has been linked to the highest sustainable work rate, or critical intensity, that can be maintained without fatigue. Exceeding the critical intensity represents severeintensity activity, and is characterized by an inability to reach steady state HR and oxygen consumption (VO₂), leading to decreased ability to sustain exertion, which may impact workability. To date, application of critical intensity and time spent above the HR_{RCP} has been explored in SFGT activities, but not in on-duty firefighting tasks. Thus, the purpose of this case study was to examine the applicability of laboratory testing for the HRRCP to characterize the physiological response to actual on-duty emergencies and compare to the HR response during a running-based assessment of critical intensity, or critical velocity (CV).

Methods: Firefighter A, a Lieutenant with 7 years of job experience (45 yrs, 82.74 kg, 180 cm, 18.13% body fat) and Firefighter B, a Captain with 21 years of job experience (39 yrs, 95.8 kg, 180 cm, 11.06% body fat) completed laboratory testing and on-duty data collection. Participants completed a maximal treadmill test (TM) during which a calibrated metabolic cart was used to determine maximal aerobic capacity (VO_{2PEAK}, mL/kg/min) and the RCP. On a separate day, participants completed a sprint-based 3-minute all-out test (3MT) where the average velocity in the final 30 seconds was used to calculate CV (m/s). Maximal HR from the treadmill test (MHR, bpm), HRRCP (bpm), and the HR that corresponded with the CV (HRcv, bpm) in the 3MT were extracted. Participants completed on-duty collections by wearing a HR monitor to capture HR throughout an entire 24-hour shift. Shift data was analyzed post-hoc to identify the HR response in fire calls that involved fire suppression (FIRE1), did not involve fire suppression (FIRE0), and medical calls (MED). Time (min) spent above the HR_{RCP} during the entire length of each call was extracted and averaged across FIRE1, FIRE0, and MED calls.

Results: Firefighter A achieved a VO_{2PEAK} of 45.4 mL/kg/min, a MHR of 184 bpm, and a HR_{RCP} of 149 bpm (80.98% MHR) during the TM test, while Firefighter B achieved a VO_{2PEAK} of 51.0 mL/kg/min, a MHR of 182 bpm, and a HR_{RCP} of 152 bpm (83.52% MHR). From the 3MT, Firefighter A achieved a CV of 3.54 m/s, a HRcv of 176 bpm (95.65% MHR), and spent 2.87 min (95.7%) of the 3MT above HRRCP. Firefighter B achieved a CV of 3.19 m/s, a HRCv of 177 bpm (97.25% MHR), and spent 2.33 (77.7%) of the 3MT above HRRCP. Across ten 24-hour shifts, Firefighter A operated above HRRCP for an average of 4.38 min during FIRE1 calls which averaged 32.54 min (n = 6), 0.10 min during FIRE0 calls which averaged 15.55 min (n = 14), and 0.03 min of MED calls which averaged 21.85 min (n = 77). Across nine 24-hour shifts, Firefighter B operated above HR_{RCP} for an average of 1.87 min of FIRE1 calls which averaged 27.23 min (n = 3) and 0.00 min of FIRE0 (n = 18) and MED calls (n = 31) which averaged 8.23 min and 21.69 min, respectively.

Conclusions: Firefighters A and B spent more time above the RCP in FIRE1 calls than in FIRE0 or MED calls. While both had similar HR_{RCP} by percent of max heart rate, Firefighter A had a lower overall aerobic capacity and a higher time above RCP during the 3MT and across all types of calls, which raises considerations regarding the role of aerobic fitness in time spent above the RCP in any type of on-duty emergency. The 3MT may be a useful field test to capture the highest work rate that can be maintained without fatigue. However, these results indicate that the job environment may impact the relative physiological intensity of work, resulting in severe-intensity exertion. Thus, managing sustainable work rate and physiological rate may be key to maximizing work capacity, which may require examination of environmental, work rate, and physiological demands in occupational settings. This finding follows a similar trend to prior work indicating that live fire environments may increase time spent above the RCP. This is the first known examination of time spent above RCP in on-duty firefighter emergencies and critical velocity as a field assessment. Due to the intense cardiorespiratory strain of firefighting, further examination into measuring and improving sustainable work capacity may be a key to improving career long health and workability. 22nd Annual Utah NORA Symposium

Cardiovascular Risk Factors and Low Back Pain Among Manual Material Handlers: A Prospective Cohort Study

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Introduction: The multifactorial etiology of low back pain (LBP) remains poorly defined, with a range of factors associated with the development of musculoskeletal disorders and LBP in particular. Among these factors are traditional cardiovascular risk factors of diabetes, heavy smoking, obesity, and elevated LDL levels.

Methods: A thorough assessment was conducted to explore the potential relationship between cardiovascular risk using the Framingham Risk assessment stratified into 9 categories, and incident cases of LBP in a sample of 732 participants. Crude and adjusted relative risk (RR) and 95% confidence intervals to assess the relationship between Framingham Risk strata and the development of new LBP were calculated.

Results: Significant (P<0.05) associations between high levels of Framingham Cardiovascular Risk Score and the subsequent occurrence of incident cases LBP; Category 4 (OR 3.05, 95% CI=1.32-7.03), Category 5 (OR 2.32, 95% CI=1.07-5.01), Category 6 (OR 3.08, 95% CI=1.44-6.61), Category 7 (OR 2.21, 95% CI=1.04-4.69) after adjustments for potential confounders, including body mass index, depression, and previous LBP severity.

Table 2. Logistic Regression Crude and Adjusted Relative Risk (RR) and 95% Confidence Interval (95%)					
CI) for LBP and Framingham Risk Categories					
Framingham Risk Categories	Crude RR	Crude 95% CI	Adjusted RR*	Adjusted 95% CI	
Category 0 (Score of -9)	1.00	Reference	1.00	Reference	
Category 1 (Score of -8 to -6)	1.79	(0.85, 3.79)	1.93	(0.90, 4.13)	
Category 2 (Score of -5 to -2)	1.85	(0.79, 4.30)	2.03	(0.86, 4.79)	
Category 3 (Score of -1 to 0)	1.42	(0.68, 2.94)	1.48	(0.71, 3.09)	
Category 4 (Score of 1 to 3)	2.64 [†]	(1.17, 5.98)	3.05 [†]	(1.32, 7.03)	
Category 5 (Score of 4 to 6)	1.97	(0.93, 4.19)	2.32 [†]	(1.07, 5.01)	
Category 6 (Score of 7 to 9)	2.69 [†]	(1.27, 5.67)	3.08 [†]	(1.44, 6.61)	
Category 7 (Score of 10 to 12)	1.98	(0.94, 4.16)	2.21 [†]	(1.04, 4.69)	
Category 8 (Score of 13 to 19)	1.73	(0.78, 3.85)	1.99	(0.88, 4.50)	
* Adjusted for Depression, BMI and Previous LBP intensity rating (0-10) [†] p<0.05					

Conclusion: The observed significant relationship between overall cardiovascular risk score and incident cases of new LBP highlights the intricate interplay between cardiovascular health and musculoskeletal disorders.

Meaningful Change

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Introduction: It is our responsibility as occupational and environmental health experts to create safer, healthier workplaces to protect those who work in our facilities. When working to create such a work environment, we are surrounded by a multitude of tools to find the most up-to-date best practices. One of the go-to tools in our arsenal is peer reviewed publications. Occupational health and safety research is being done worldwide, and researchers are discovering new information, methods, and data that can keep our workforce safer and healthier. When new information is published, what is the best way to take research and turn it into meaningful change in an organization? Trying to adjust or change already established processes and procedure or force a change in the daily routine of workers is not the easiest task, and there tends to be push back against the change. It can be an uphill struggle trying to implement what may seem to us as health and safety experts, a small or minor change. Using phrases like "because it's what is best" or trying to shoehorn and force the change causes a bigger headache for everyone, and often it seems like finding the research is the easy part of the process. There are numerous change frameworks and methods that change practitioners use to make change within an organization. Pulling different elements together can help create a more successful change framework and method.

Methods: Literature review and firsthand experience was utilized to identify methods and elements to help implement change in an organization.

Results: There is no universal standard method of implementing change, many different frameworks and methods exist and are used by different industries (Phillips & Klein, 2023). Research also suggests that one's framework and model for implementing change is mostly developed on-the-job (Phillips & Klein, 2023). There are four elements that can be added to any methodology used that could increase the success of the implementation, they are 1) Do your due diligence, ensure what you have is applicable to your industry 2) Rely on your experts, tap into the expertise of those who do the work day in and day out (Marquet, 2012), 3) The why, explain to people the reason behind change (Deljoy, et al., 2017) (Galbraith, 2018), 4) Owning it when you are wrong, if a change does not work out or the plan does not go according to plan don't let your ego get in the way and be willing to admit your mistake (Willink & Babin, 2017).

Conclusions: Traditional and modern change frameworks and methods all have positive and negative attributes associated with them. Different industries, companies, and individuals will have different methods of implementing change withing there organization based on many different factors. While some methods will be very successful in one area, they may not work well in another area. Change practitioners must develop and establish a method that works well for their organizations and industry culture. While each person has their own change framework and method, there likely is not a perfect method that will work in all situations and workplaces. Adding the four elements of doing your due diligence, relying on your experts, giving the why, and owning it when you are wrong to an established change framework and model can be useful when implementing meaningful change in an organization.

Richards Lecture Speaker: Michael Belzer

{Admati, 2013 #17430}Michael H. Belzer, Ph.D. Professor of Economics and Director of Graduate Studies Economics Department; Wayne State University, Detroit <u>https://www.michaelbelzer-saferates.com/</u>

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Dr. Michael H. Belzer is Professor of Economics at Wayne State University, teaching labor economics and industrial organization. A short- and long-haul truck driver for ten years, Belzer has about 750,000 miles of heavy truck driving experience.

Dr. Belzer is the author of Sweatshops on Wheels: Winners and Losers in Trucking Deregulation (Oxford University Press: 2000) and dozens of articles, book chapters, and monographs on trucking industry and labor market issues, including peer reviewed articles on trucking and commercial motor vehicle (CMV) driver safety and health issues.

He founded the Transportation Research Board (TRB) Committee on Trucking Industry Research and served as chairman for 15 years, serving now as Emeritus Member. He is a founding and 12-year Member (now Friend) of the TRB Committee on Truck and Bus Safety and an 18-year Member (now Friend) of the TRB Committee on Freight Economics and Regulation. He has served on the NIOSH/NORA Transport, Warehouse, and Utilities Sector Council since 2006.

Dr. Belzer served on the National Academies of Sciences, Engineering, and Medicine National Research Council Committee for Review of the Large Truck Crash Causation Study, and on the National Academies CNSTAT Expert Panel on the Review of the Compliance, Safety, and Accountability Program of the Federal Motor Carrier Safety Administration. He testified before Congress in 2012, calling for closer cooperation between the Department of Labor and the Federal Motor Carrier Safety Administration of the U.S. Department of Transportation.

Over the past 25 years, Dr. Belzer's research agenda has shown that economics – freight and passenger rates as well as compensation – is an extremely powerful and consistent predictor of CMV driver safety and health, as well as motor carrier safety. Selected recent research and papers:

• Belzer, Michael H. Forthcoming 2024. "Trucking Collective Bargaining: The Problem of Conflicting Labor Market Governance." In R. Stanger, P. Clark, and J. Delaney (Eds.), *Union Organizing and Collective Bargaining at the Crossroad: Renewal or Continued Decline?* Labor and Employment Relations Research Volume. Cornell University Press.

• Ju Shengyang and Michael H. Belzer. 2024. "Follow the Money: Trucker Pay Incentives, Working Time, and Safety." *Economic and Labour Relations Review*. March. <u>https://doi.org/10.1017/elr.2024.5</u>.

• Ryley, Walter T. and Michael H. Belzer. 2023. Compensation and crash incidence: Evidence from the National Survey of Driver Wages. *The Economic and Labour Relations Review* **34**(3), 118–139. <u>https://doi.org/10.1017/elr.2022.13</u>.

• Wong, Imelda S., Quay Brian, Emily Irvin, and Michael H. Belzer. "Describing economic benefits and costs of nonstandard work hours: A scoping review." With Imelda S. Wong, Quay Brian, and Emily Irvin. *American Journal of Industrial Medicine*. 22 October 2021. <u>https://doi.org/10.1002/ajim.23302</u>.

• Practitioner magazine for non-economists: "Trucking Industry Blues," *Perspectives on Work*. Champaign, IL: Labor and Employment Relations Association, 52-53. Volume 27. October 2023. https://uofi.app.box.com/s/hnqaw4kion283m1x22gpa8bsfzfe67p0/file/1325669898019

• Editorial: "The Economics of Long Work Hours: How Economic Incentives Influence Workplace Practice." *Industrial Health*, 58(5), 399–402. September 2020. <u>https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7557409/pdf/indhealth-58-399.pdf</u>

His research suggests that safety pays, and it pays to be safe.

Burnout Associations Using Job Demands and Resources Model Among Lawyers

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Introduction: Law professionals impact many aspects of life for society. They are many aspects that they work in, these include but are not limited to, business, family lives, criminal cases, and copywriting. With so many aspects of our lives affected by lawyers, they make up a large aspect of our society. There are approximately 1.3 million lawyers who are licensed and working in the United States as of 2022 (American Bar Association, 2022). Even as this is the case there have been relatively few studies to identify how different aspects of their jobs effect their mental health. Burnout is a key issue for many occupations and professionals. To date there has been one study which looked into the association between aspects of the job and burnout among lawyers (Bergin, 2014). The Job Demands-Resources theory (JDR) for burnout explains how different demands at a job can cause somebody to lose resources while there are also aspects of life that can increase the amount of resources that a person has at their disposal. This theory can help to understand associations between different aspects of the job or of their life which could influence how much burnout is occurring.

Methods: A cross-sectional study of lawyers in New Jersey. A questionnaire went to law professionals in New Jersey which they were asked to fill out. We identified a few different aspects of the job which could tax resources, these being financial stress and expected work outside of normal business hours and two things which could add resources, wellbeing activities and social support at the workplace. Some example questions were" In the past month, how many hours do you work in an average week?" With multiple choice answers to follow and "How many additional hours on average do you work during the week outside of your normal business hours (e.g., 8-5 Monday through Friday, or other if your regular business hours vary from this?" There were also a couple of questions to analyse the level of burnout that a person is feeling. An example of the questions is: "I feel burned out from my work? Never, A few times a year or less, Once a month or less, A few times a month, Once a week, A few times a week, or Every day". Using the results from these questions we will get odds ratios for these different activities for how these activities affect burnout among lawyers.

Results: The odds ratios for expectations to work outside of business hours is 12.764 (4.012-40.599) for those who have a higher expectation vs those who do not feel they have the expectation. Those who have financial stress have 21.525 (4.493 to 103.131). Those lawyers who feel they have social support are much less likely to have burnout than those who don't. 8.401 (1.173-40.265). Those who don't participate in wellbeing activities are more likely to be burned out than those who don't 11.132 (5.739-21.593). It is also shown that social support is a protective factor for expectation to work outside of business hours with a pvalue of .0046.

Conclusions: This paper has shown that there is an association between burnout and higher financial stress and expectation to work outside of business hours. Participating in wellbeing activities and having higher social support are associated with lower levels of burnout among lawyers. This can be used to help to protect lawyers in the future from these high levels of burnout.

Analysis of Vicarious Trauma and mental health outcomes in Lawyers

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Introduction: Research has found that law professionals have significantly high rates of adverse mental health concerns, including anxiety, depression, suicidal ideation, and substance abuse. Relatively little amounts of research conducted on the effects of vicarious traumatization (VT) within this population. Of the research out, there is evidence to suggest lawyers have higher levels of VT when compared to mental health professionals. Thus, a relationship worthy of exploring is that between the vicarious traumatization lawyers and mental health outcomes previously found to be concerning within this population, specifically depression, anxiety, and suicidal ideation. We believe that there will be a statistically significant relationship between increased perceived VT and reported depression, anxiety, and suicidal ideation.

Methods: This data was collected from a large study focusing on depressive symptoms and suicidal ideation in lawyers and other law professionals. A total of 1643 lawyers were surveyed and assessed with a 90-item questionnaire. To assess the exposure of VT, two questions were used asking participants about frequency and impact of secondary trauma over the previous month. Measures that assessed the outcomes of interest include the patient health questionnaire 9 (PHQ-9) for depression and questions asking about experiences with anxiety and suicidal thoughts over the previous two weeks. The outcome of depression was dichotomized into the previously validated scores (PHQ-9 score \geq 10) in line with diagnostic criteria of major depressive disorder. Suicidal ideation and anxiety were dichotomized into yes or no. Mean and standard deviation were calculated for discrete and continuous variables. Frequency and percent were calculated for categorical variables. Crude odds ratios (ORs) and 95% confidence intervals (95% CI) were calculated using logistic regression, with the reference set to a score of "Never" and "No Impact" for VT frequency and impact, respectively. An alpha level of 0.05 was used for determining statistical significance. Further analysis will be conducted to assess for the effect of confounders and mediation.

Results: Both vicarious traumatization analyses for each of the outcomes (depression, suicidal ideation, and anxiety) produced statistically significant results. This indicates a relationship between increasing perceived vicarious traumatization frequency and impact with feelings of depression, anxiety, and suicidal ideation. Table 1 provides the crude ORs and 95% CIs for just VT frequency related to these outcomes.

	Depression	Anxiety	Suicidal Ideation
VT Frequency	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
"Rarely" vs. "Never"	1.93 (1.39, 2.68)	2.96 (2.2, 3.98)	1.71 (1.08, 2.72)
"Occasionally" vs. "Never"	2.44 (1.75, 3.389)	4.204 (2.99, 5.91)	1.73 (1.07, 2.79)
"Often" vs. "Never"	5.67 (3.48, 9.26)	6.69 (3.29, 13.6)	4.72 (2.6, 8.56)
"Very Often" vs. "Never"	9.25 (5.08, 16.84)	15.12 (4.68, 48.86)	9.05 (4.875, 16.82)

Table 1. Crude ORs and 95% CIs for VT Frequency ("Never" set as reference) and all outcomes

Conclusions: Findings from the crude analyses have shown a significant relationship between the perceived levels of vicarious traumatization frequency and impact on individuals reported depression, anxiety, and suicidal ideation. These are crude findings, and analyses are ongoing to calculate ORs for confounding factors. Future research should focus on investigating if there is a dose response, or even causal relationship.

A Motorized Ankle Orthosis for Occupational Injury Prevention

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Introduction: Occupational injuries cost the US more than \$60 billion annually [1]. Musculoskeletal disorders, including strains, sprains, and tendonitis, contribute to this economic burden by delaying return to work after injury. The leading causes of occupational injuries associated with musculoskeletal disorders are overexertion, falls, slips, and trips [2]. Furthermore, occupations requiring physical labor have an increased risk of acute trauma, as well as foot and ankle injuries [1]. Workers in these settings must ambulate on uneven surfaces, climb ladders, transport loads, or perform other activities in which ankle stability and mobility are critical. Wearing work boots can help stabilize the ankle; however, they limit the joint's range of motion, and the additional weight increases the risk of trips and falls [3]. Although ankle braces present a lightweight solution for stabilizing the ankle joint, these orthoses further limit the ankle's range of motion and ability to maintain balance on variable terrains, contributing to increased fall risk. Here, we propose a lightweight, motorized ankle orthosis to supplement the strength of the ankle joint while stabilizing it, supporting a full range of motion and adaptation to variable terrains. The device's motor generates additional energy at the ankle joint, potentially reducing the risk of overexertion. We believe that supporting the ankle joint with a motorized orthosis has the potential to reduce fatigue and improve mobility without increasing fall risk, ultimately preventing occupational injuries.

Methods: We designed a lightweight and autonomous motorized ankle orthosis (Figure 1(a)). The frame of the motorized orthosis connects to the user's shank through a plastic cuff. The distal end of the orthosis attaches to a plate inside the user's shoe. The orthosis features passive degrees of freedom (pDOF) to align the robotic joint with the user's ankle, making the device more effective and comfortable [4]. The pDOFs can be locked after donning the orthosis to increase stability. The device, including the mechanics, electronics, and battery, is self-contained at the shank. At just 1240g, the motorized ankle orthosis is lighter than most work boots, which Figure 1: (a) CAD model of the motorized ankle weigh an average of 1450g. We recruited three healthy subjects to complete validation testing with the motorized ankle orthosis. Each



orthosis. (b) Subject walking on variable terrain with the motorized ankle orthosis.

subject walked on a treadmill while the motorized orthosis provided autonomous assistance. The orthosis provided dorsiflexion torque during swing and early stance to support the ankle. It also provided plantarflexion torque during push-off to assist propulsion. Additional pilot testing was completed to evaluate overground walking on variable terrain platforms (Figure 1(b)). We assessed the performance of the motorized ankle orthosis by analyzing the assistance provided by the device and the subject's ankle joint range of motion during treadmill walking.

Results: The average peak plantarflexion torque provided by the orthosis was 0.52±0.05 Nm/kg, equal to approximately onethird of the biological plantarflexion torque typically required for level-ground walking [5]. The subjects' average ankle joint range of motion was 35°±8°, slightly greater than normative values. During the overground walking trials, the ankle joint and orthosis effectively adapted to the variable terrains.

Conclusions: Our results suggest that the proposed motorized orthosis can provide high levels of assistance without restricting ankle joint range of motion. This device has the potential to improve mobility and reduce fatigue, which may reduce the risk of injury due to overexertion and trips. Further research is necessary to assess the potential of this device for supporting the ankle joint during variable activities in occupational settings.

Relationship Between Heart Rate Variability and Recovery Activities Utilized by Career Firefighters

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Introduction: For the 1.2 million firefighters in the United States, the ability to achieve readiness to perform the job of a firefighter involves engaging in activities to maintain and improve overall health and fitness, as well as to prompt recovery following an emergency call. To facilitate similar objectives within the sport athlete population, and with the understanding that recovery occurs both psychologically and physiologically to counteract the effects of stress, scholars working with sport athletes have recently examined the association between perceptions of recovery and heart rate variability (HRV), an objective measure of recovery. However, this psycho-physiological recovery relationship has not yet been examined with firefighters, and instead, researchers have focused on the relationship between perceptions of *stress* and HRV. Concurrently exploring psychological and physiological components of recovery is important as poor recovery may interfere with readiness to respond to emergency calls as well as the ability to sustain readiness for job duties across an entire shift. When a firefighter is not appropriately recovered, workability of the firefighter could be negatively impacted, leading to poor physical and/or mental performance. As such, the purpose of this study was to determine the relationship between an objective measure of recovery (i.e., HRV) and a subjective measure of recovery (i.e., the Assessment of Recovery Activities for Athletes-Firefighters [ARAA-FF]) across four weeks.

Methods: 28 (26 male, 2 female) career firefighters (M_{age} =41.33 years; SD = 9.18 years) from a Midwestern metropolitan fire department volunteered to participate. HRV data were collected using a chest strap transmitter. A 5-minute heart rate recording was self-taken by the firefighters every morning upon waking (between 0600 and 0900) for four weeks both on- and off-duty. R-R intervals were extracted from the recordings using the Elite HRV smartphone application. The R-R intervals were then analyzed to determine the time-domain HRV indices of square root of the mean sum of the squared differences (RMSSD). To reduce any potential non-normality or skewness of HRV data, the RMSSD values were log transformed (lnRMSSD) and averaged across the week for each firefighter. Additionally, the ARAA-FF was distributed to firefighters at the end of each week via the online survey platform Qualtrics. Separate one-way repeated measures analyses of variance (RM ANOVA) were used to examine change in average weekly lnRMSSD and change in each of the 10 ARAA-FF subscales across the four-week time. Spearman's correlations were used to evaluate the chronic relationship between average weekly lnRMSSD and each of the ARAA-FF subscales across all 4 weeks. An alpha p < 0.05 determined statistical significance.

Results: Across the four-week time period, there was a significant effect for *Readiness* (F(3, 25) = 3.51, p = .030, $\eta^2 = .296$), *Relaxation* (F(3, 25) = 3.93, p = .020, $\eta^2 = .321$), *Autonomy* (F(3, 25) = 3.20, p = .040, $\eta^2 = .278$), and *Community* (F(3, 25) = 4.77, p = .009, $\eta^2 = .364$). No significant differences between weeks emerged for lnRMSSD (M = 3.57; SD = 0.58). Additionally, no significant relationships emerged between lnRMSSD and any of the 10 recovery activities as indicated on the ARAA-FF.

Conclusions: The absence of change in HRV across weeks may have been a function of a lack of engagement in recovery activities by the firefighters. It is also possible that the recovery activities chosen by the firefighters were not appropriate and underrestored the autonomic nervous system (ANS), thus, HRV remained unchanged. It is interesting to note that the aggregate mean HRV value would be considered low and below most published normative values for a non-firefighter population. As such, the potential chronic suppression of the ANS in the firefighter could require novel recovery approaches. Furthermore, the lack of correlation between HRV and the ARAA-FF may suggest that each measure uniquely examines a different aspect of the recovery process independently representing the physiological and psychological components, respectively.

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Ergonomic Evaluation of Fine-Paper Collation Process of Printing Press

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Introduction: A large Utah printing facility has requested an ergonomic evaluation of their fine-paper collator to inform their new collation station design. In the print industry, collation is the process of assembling stacks of paper into individual copies in their final, published sequence [1]. Limited research has been done specifically focusing on industrial printing biomechanics; however, currently available research has shown that up to 76.5% of print workers experience musculoskeletal (MSK) pain [2]. Low back pain was reported to be the most common form of pain, being present in approximately 61.2% of workers [2]. This number may be even higher due to workplace cultures and sentiments that discourage expressing pain or discomfort, which may lead to relevant injuries being underreported [3]. Thus, the objective of this study is to identify and quantitatively assess ergonomic risks posed by the current fine-paper collation procedure at a Utah printing facility to improve employee MSK outcomes at the site's new collator configuration.

Methods: Informal interviews with employees working 8-hour shifts were conducted to identify potential areas of improvement. Workstation dimensions were directly measured, and task video footage was collected from a rear and side-view to generate joint-angle approximations with *ImageJ2* [4]. To evaluate postural ergonomic risk, the Rapid Entire Body Assessment (REBA) was used for three lift origins and destinations in addition to paper-stack split preparation. For back compressive forces (BCFs) at the L4/L5 vertebrae, 3DSSPP was used to simulate stack-splitting and one lift for a 5th-percentile male. The NIOSH Revised Lifting Equation (RLE) was used to analyze six lifts from paper stacks to the collator. The sequence of lifting, carrying, and lowering stacks to the collator was assessed for metabolic expenditure via Garg metabolic equations and task accessibility with Liberty Mutual Manual Material Handling (LMMMH) Tables. Work-rest cycling was also calculated when task expenditures exceeded physical work capacities (PWCs) by Chaffin et. al. [5]. Descriptive statistics were performed on starting and ending lifting posture risk scores from REBA.

Results: For the NIOSH RLE, the final Composite Lifting Index (CLI) of the lifting task is 1.4 and the mean observed L4/L5 BCFs for lift postures was 385.25 ± 181.1 pounds. An estimated average caloric expenditure of 4.49 kcal/min was calculated for 5th-percentile males, and 4.74 kcal/min for 50th-percentile females. For an 8-hour workday, the average female print worker PWC was exceeded; thus, their resulting duty cycle was 11 minutes of rest per hour. For REBA, the mean start-of-lifts risk score was 6.67 ± 2.31 ; whereas, the average end-of-lift score was 2 with a standard deviation of 0. Lastly, the stack-splitting position analyzed had a REBA score of 8. Using the LMMMH Tables, lifting, lowering, and carrying tasks required at the collator were able to be readily performed by >90% of both working male and female populations.

Conclusions: Our findings suggest that the collator loading task is accessible and reasonably safe posturally and with respect to BCF, but there remain areas of potential improvement regarding lift frequency and from-pallet lift postures. From the LMMMH Tables, an overwhelming majority of the working population is capable of collator loading and the mean L4/L5 BCF forces were all less than NIOSH's threshold of 770 pounds, indicating reasonably safe postures and loads for lifts in isolation [6]. From the RLE, the final CLI value of 1.4 suggests that changes should be made to reduce the risk of MSK injury to workers. Moreover, per REBA and on average, start-of-lift postures and the posture to prepare a new paper stack indicate potential elevated ergonomic risk and a greater need for mitigation relative to other evaluated tasks. In contrast, the average end-of-lift posture value of 2 suggests that changes to the collator's height are not as ergonomically crucial as modifications to other aspects of the station design. To redress these concerns, we recommended leadership and employees consider workspace modifications including the reduction of lift frequency by increasing collator loading capacities/throughput, performing routine employee training to minimize twisting during lifts, and reducing the vertical distance from the pallet to the collator to reduce bending at lift origins.