The University of Utah
Virtual NORA Symposium

UTAHNORA

Abstract Booklet | 2021

THE UNIVERSITY OF UTAH
DEPARTMENT OF MECHANICAL ENGINEERING

Rocky Mountain Center for Occupational & Environmental Health (RMCOEH)

CDC Centers for Disease Control and Prevention

Welcome Address

We are delighted by your virtual attendance this year at our Annual NORA Young and New Investigators Symposium. This year commemorates our 19th 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.

This year we are hosting the virtual symposium using Gather.Town. To connect online using this platform, you can find detailed instructions here, or you can enter the symposium at Dashboard | Gather and enter the NORA Symposium Space.

We would also like to thank Drs. Ken d'Entremont and Don Bloswick for reviewing abstract submissions, and Liz Reiser for her efforts in taking care of everything else. Please contact Liz.Reiser@mech.utah.edu if you need anything during the symposium. She will be "present" in Gather Town at the virtual registration desk.

This symposium is made possible in part through the generous support of the Rocky Mountain Center for Occupational and Environmental Health, the Department of Mechanical Engineering, and funding from NIOSH (NIOSH Education and Research Center training grant T42/CCT810426-14). The views expressed by our presenters do not necessarily represent the official views of CDC or NIOSH.

19th Annual *Virtual* NORA Symposium Schedule
Friday, April 16, 2021

Time		
8:00	**WELCOME** **Andrew S. Merryweather, University of Utah**	
8:10 - 9:20	**18th Annual Paul S. Richards, MD, Endowed Distinguished Visiting Lectureship in Occupational Medicine**	***Keynote: Dan Clark, The Art of Significance***
9:20 - 9:30	**Break**	
Session 1: Ergonomics and Biomechanics		***Title***
9:30	Alexa Zimbalist, UC Berkeley	*The importance of concurrent exposures: assessing awkward shoulder posture and forceful hand exertion on neck and shoulder disorders in a prospective cohort of manufacturing workers*
9:45	William Frantz, Washington State University	*Neck angle, neck length and disc height in functional head and neck postures*
10:00	Athena Nguyen, University of California, Berkeley	*The relationship between posture changes, physical activity, and musculoskeletal discomfort in office workers*
10:15	Anita Vasavada, Washington State University	*Prediction of vertebral position from external markers: Multivariate regression and deep learning methods*
10:30 - 10:45	**Break**	
Session 2: Industrial Hygiene, COVID		
10:45	Constancia Dominguez, UC Berkeley	A survey of California grocery workers work experience during the COVID-19 pandemic: implications for policy
11:00	Alec Trollan, University of Utah	*Risk of Particulate Dust Inhalation of Human Cadaveric Bone in a Non-Pathological Research Laboratory Environment*
11:15	Ted Medina, University of Utah	*Evaluation of two hazardous waste storage areas at a local facility for compliance and recommendations.*
11:30	Sharly Coombs, University of Utah	*Hazards Assessment of a Composites Manufacturing Company*
11:45 - 12:30	**Lunch Break**	
12:30 - 13:30	**Poster Session**	*(P1) Uchenna Ogbonnaya-Assessing a relationship between Burnout and drug use disorder among Lawyers* *(P2) Katherine Castro-Perceived COVID-19 challenges among fire-based first responders* *(P3) Hyejung Lee-Association between major depressive disorder and work and personal factors among Utah lawyers* *(P4) Abdulrazak Balogun-Personal and work-related risk factors and protective safety resources associated with musculoskeletal disorders among stone, sand and gravel mining industry workers: perspectives from management.* *(P5) Lito Amit-Effectiveness of Ergonomic Intervention in Work-related Postures and Musculoskeletal Disorders of Call Centre Workers: A Case-control Study* *(P6) Katherine Hagman-Industrial Hygiene Evaluation of Selected Hazards in Composite Fiber Manufacturing Operations* *(P7) Shelton Lo-Occupation and Relation to Lung Cancer Recurrence and Overall Survival in the Boston Lung Cancer Survival Cohort (BLCS)* *(P8) Celal Gungor-Safety Sign Comprehension of College Students* *(P9) Braydon Black-FMCSA seizure study* *(P10) Katrina Cernucan-Do Anti-Fatigue Industrial Insoles Affect Static Balance?*
Session 3: Slip, Trip, Fall, Physical Acitivity		
13:30	Trevor Pugh, University of Utah	*Risk of Falls Among Groundskeepers Maintaining Terraces at a Public Institution*
13:45	Spencer Claflin, University of Utah	*How do sleep and low back pain relate to 1-year prevalence of slips, trips, and falls among truck drivers?*
14:00	Chadi Ellouzi, Rowan University	*Rapid Trip Detection Based on Dynamic Time Warping*
14:15	Chapman Cox, University of Utah	*Depression in law professionals: does physical activity really matter?*
14:30 - 14:45	**Break**	
Session 4: Safety and Hazards in the Workplace		
14:45	Patricia Blair, Indiana University	*Passive safety leadership, stress and firefighter safety behavior outcomes*
15:00	Aurora Le, University of Michigan School of Public Health	*Examining employees' intention to evacuate during a fire alarm in a university workplace setting*
15:15	Nicholas Gomez, University of Utah	*Work-related Amputations in the California Workers' Compensation System*
15:30 - 15:45	**Break**	
15:45	**Student Awards/Closing Remarks**	

List of Abstracts (In Order of Presentation)

The importance of concurrent exposures: assessing awkward shoulder posture and forceful hand exertion on neck and shoulder disorders in a prospective cohort of manufacturing workers

Zimbalist, A[1], Harris-Adamson, C[2], Rempel, D[3], Feng, L[3]

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Introduction: Awkward shoulder posture and forceful hand exertion have been linked to neck and shoulder disorders. Previous studies assessing these exposures are primarily cross-sectional and focus on large degrees of shoulder posture deviations (>60^{o}). Very few studies have examined smaller deviations from neutral shoulder posture. Furthermore, there is a lack of studies that concurrently quantify awkward shoulder posture during forceful hand exertion and the impact it may have on neck and shoulder disorders. This study aims to examine the associations between workplace biomechanical factors and incidence of neck and shoulder disorders, adjusting for age, sex and body mass index. The role that forceful hand exertion while in awkward shoulder posture may play in development of neck and shoulder disorders is of particular interest.

Methods: The study population included 349 employees in four manufacturing industries who were followed for up to 28 months. Force, repetition, duty cycle and shoulder posture exposures were measured across each job task and utilized to calculate job-level time-weighted average exposures. Participant questionnaires and physical examinations were conducted every four months to identify incident neck and shoulder disorders. Cox proportional-hazards regression adjusted for age, sex, and body mass index was used to assess the relationship between the biomechanical exposures and incident neck and shoulder disorders.

Results: There were 18 incident cases of neck and shoulder disorders during the 372.5 years of follow-up. After adjusting for age, sex, and body mass index, the largest observed associations with the outcome were for the following exposures: more than 33% time spent in forceful hand exertion (HR=2.26; 95% CI 0.85-6.04), forceful repetition rate of more than 20.74 reps/min (HR=1.60; 95% CI 0.59-4.31), and spending more than 18.62 degrees of shoulder abduction while in forceful hand exertion (HR=1.82; 95% CI 0.70-4.74). None of the associations were statistically significant, likely due to low power.

Conclusions: Forceful exertions of the hand, both in terms of duty cycle and concurrent shoulder posture deviations, were associated with increased rate of workplace neck and shoulder disorders, though confidence intervals were wide. More research on the association between forceful hand exertion while in slight shoulder deviation and musculoskeletal disorders are needed.

Neck angle, neck length and disc height in functional head and neck postures

William Frantz[1], Rajal Cohen[2], Anita Vasavada[1]

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2 University of Idaho, Moscow, Idaho

Introduction: Neck pain is the fourth leading cause of disability in the world, affecting 27-48% of the population in their life [1,2]. A major contributor to neck pain is holding awkward postures for an extended period, causing fatigue of the neck muscles and compressive loads on the discs. This study aims to quantify cervical vertebral positions in common postures in the workplace and daily life; to evaluate how instructions to improve posture may alter vertebral positions; and to investigate how different operational definitions of the neck segment affect findings. The following hypotheses were investigated: (1) defining the neck segment using an anterior landmark will reflect vertebral positions better than a definition using the C7 spinous process. (2) In postures typically associated with neck pain, neck length and intervertebral disc space will be smaller than in a typical neutral (baseline) posture; (3) when subjects are asked to assume their tallest sitting height, neck length and intervertebral disc space will increase compared to baseline.

Methods: Nine subjects (5M, 4F, ages 19-24) were recruited for the study. Lead beads and reflective markers were placed on landmarks on the head and neck. Subjects were instructed to assume a neutral (baseline) sitting posture (looking straight ahead) while they were simultaneously photographed and X-rayed. This was repeated (in randomized order) for three additional postures implicated in neck pain: extension (looking slightly upward), forward head posture (head is in front of the trunk while the line of sight remains horizontal), and texting posture (phone near lap); and with instructions to, "Assume your tallest sitting height." The neck segment was defined in two different ways from external landmarks: (1) from the tragus to the C7 spinous process and (2) from the tragus to the midpoint of the C7 spinous process and sternal notch. For both of these line segments, neck angle was defined as the angle between that line and horizontal (NA1 and NA2, respectively), and neck length was defined as the distance between the markers (NL1 and NL2). Intervertebral disc height was calculated from x-rays at the anterior and posterior side of vertebral bodies from C2-C7. Curvature was calculated as the percent difference between an arc length connecting the midpoints of C1-C7 and a straight line connecting those points. All measurements were compared to the neutral baseline posture values for each subject individually.

Results: Although the absolute angles NA1 and NA2 were significantly different (p <0.001), the change in neck angle from baseline was only slightly different. Change from baseline for NA1 (vs. NA2) was 4.6° (vs. 3.1°) extended in the "tallest seated height," 4.7° (vs. 5.0°) extended when looking up, 16.6° (vs. 18.1°) flexed in forward head posture, and 24.0° (vs. 24.4°) flexed while texting. The definition of neck length affected the change in neck length from baseline. Using NL1, neck length decreased 4.8% in the extended posture and increased 8.2% in the "tallest" posture, 8.4% in forward head posture and 8.5% in the texting posture (p < 0.01 for all). Using NL2, neck length did not change significantly in the "tallest" or extended postures, and it decreased 4.9% in forward head posture and 9.3% in the texting posture (p<0.001). Posture affected disc height on the anterior side, with 10-17% decreases for "tallest," forward head posture and texting at 2-3 vertebral levels (p<0.001), and 8% increase for extension at one level (p<0.05). In the "tallest" posture, changes in curvature tended toward decreased lordosis/straightening or even kyphosis relative to baseline. In extension, lordosis increased. The other postures did not lead to changes in curvature.

Conclusions: The points used to define neck angle and neck length significantly affected the results. The most commonly-used definition of neck angle is NA1 [3]. While this angle is important for comparison to angles reported in other studies, we found that NL2 is a better representation of neck length than NL1 (better correspondence with disc height changes), because it runs approximately along the middle of the neck rather than towards the back of the cervical spine. Using NL2, neck length and disc space decreased in texting and forward head postures compared to neutral. However, neck length and disc height did not increase in the "tallest" sitting height. In fact, disc height *decreased* on the anterior side of the spine because of a change in curvature. Future work will include measures of muscle activity and will incorporate these data into computational neck models to further evaluate the biomechanical loads on neck tissues in these postures.

[1] Cote, P., *et al., Spine*, 2008, 33(4S):S60-74. [2] Hoy, D., *et al., Ann Rheum Dis*, 2014, 73(7):1309-15. [3] Grimmer-Somers *et al., J Manip Phys Ther*, 31:509-517, 2008.

The relationship between posture changes, physical activity, and musculoskeletal discomfort in office workers

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Introduction: Prolonged sitting is associated with higher risk of musculoskeletal discomfort (MSD); thus, reducing sitting has been proposed to mitigate the negative effects of prolonged sitting. However, the amount and frequency of standing and physical activity required to reduce risk of MSD is less understood. The aims of this cross-sectional analysis were to 1) understand the relationship between daily movement patterns and MSD among office workers and whether work versus leisure activity was more strongly associated with MSD and 2) compare differences in daily movement patterns among those who sit for longer periods (prolongers) versus those who do not (breakers).

Methods: 26 participants completed baseline surveys and wore an inertial measuring unit to quantify movement behavior including time spent in sitting, standing, walking over a 48-hour period, stratified by work and leisure time. Additionally, the number of steps and the number of transitions between postures were collected. Participants were listed as "breakers" (BRK) and "prolongers" (PRO) based on whether or not they changed their posture during a 2-hour sitting bout. The relationships between movement behavior and MSD were evaluated using Spearman correlation coefficients, two-sample t tests, and Mann Whitney U tests, then stratified by and compared between breakers and prolongers.

Results: Correlations show that steps(r^2=-0.26), standing(r^2=-0.39), and walking(r^2= -0.31) were negatively associated with MSD, whereas sitting duration was positively(r^2=0.20) associated with MSD. The direction of correlations between posture, activity, and MSD were also reflected during work and leisure time. Prolongers spent more time sitting compared to breakers (PRO=10.55(1.28) hours/day; BRK=9.01(3.02) hours/day; p=0.12) and tended to have more overall MSD (PRO=9.00(7.00); BRK=3.50(7.63); p=0.05). Although prolongers had slightly more transitions between postures than breakers (PRO=50.00(14.88); BRK=46.00(16.88); p=0.83), breakers spent more time in standing (PRO=5.56(0.76); BRK=6.23(3.18); p=0.42) and walking(PRO=1.33(0.37);BRK=1.82(0.41); p=0.08).

Conclusions: Standing and walking durations during work and leisure time were moderately negatively correlated with MSD while sitting duration was positively correlated with discomfort. Those who took breaks during a 2-hour sitting bout had longer standing and walking durations during work and leisure time compared to those who did not take breaks, though differences were not statistically significant**.** Future interventions should incorporate a Total Worker Health approach by encouraging increased standing and walking throughout the day to reduce MSD among office workers.

Prediction of vertebral position from external markers: Multivariate regression and deep learning methods

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1 Washington State University, Pullman, WA

Introduction: Neck pain is a significant problem in many occupations, with high financial and disability cost [1,2]. Evidence-based practices for the reduction of neck pain need to be based on mechanistic relationships such as those between posture and load. These relationships can be obtained using biomechanical models and then applied in the workplace while measuring postural exposure. Certain postural measures such as head and neck angle can be measured externally, but vertebral positions (internal neck posture) are difficult to ascertain from external measurements and are essential for accurate predictions from biomechanical models. Common assumptions for defining vertebral positions in spine musculoskeletal models are that (1) vertebral motion is distributed as a specific function of overall spine motion and (2) intervertebral centers of rotation are fixed. We have found that using these common assumptions to estimate vertebral positions leads to biomechanical predictions that are significantly different from those made when directly measuring vertebral positions by X-ray [3]. The objective of this work is to develop and test new algorithms for predicting vertebral position from external measurements for neck musculoskeletal modeling. Specifically, we evaluated a statistical regression model (Multivariate Regression and Covariance Estimation; MRCE) and deep learning.

Methods: Postural data were obtained from simultaneous X-rays and photographs in a previous study of 30 seated subjects in 5 positions (neutral posture and while using a tablet computer in four different conditions) [4]. External landmarks measured from photographs were the tragus, canthus, C7 spinous process, sternal notch and iliac crest. X-ray measurements were horizontal, vertical and angular position of vertebrae. Two methods were used to predict vertebral positions and angles from external markers: (1) MRCE [5], which provides an estimate of a multiple regression model while accounting for the correlation between response variables (in this case, vertebral positions and angles). (2) Deep learning (densely connected networks). Vertebral positions and angles predicted by both methods were compared to the X-ray data using the RV coefficient, a generalization of the Pearson correlation coefficient. The error between predicted and actual data for the MRCE method was also compared to the error calculated in our previous study using common assumptions mentioned in the Introduction [3].

Results: Both MRCE and deep learning methods were able to provide improved prediction of vertebral positions and angles compared to methods used in our previous study. RV coefficients between predicted and actual data were 0.869 for MRCE and 0.859 for deep learning. The errors for vertebral angle and position between the MRCE prediction and X-ray data were significantly lower ($p < 0.001$) than the errors in our previous method. Errors in vertebral angle for MRCE averaged 4.5° (SD 3.2°) compared to 17.4° (SD 12.3°) for the previous method. Errors in position of the vertebral centers were 0.7 cm (SD 0.4 cm) compared to 1.7 cm (SD 1.2 cm) for the previous method.

Conclusions: Both regression and deep learning methods provide improved prediction of vertebral positions and angles from external markers compared to our previous study. MRCE methods are recommended for biomechanical models. Advantages to regression (MRCE) models are that coefficients can be reported and used in other studies. This makes MRCE models more accessible and easier to implement in biomechanical models, whereas deep learning methods provide more of a "black-box" approach and are not as easily understood in terms of anatomy and physiology. These algorithms will improve the predictions of biomechanical models to calculate loads in the neck due to postural exposure. Their use will allow for improved guidelines and interventions to reduce the incidence of neck pain in the workforce.

References:

[1] Hoy, D., *et al. Ann Rheum Dis*, 73(7):1309-1315, 2014.
[2] Dieleman, J.L., *et al. JAMA*, 323(9):863-884, 2020.
[3] Vasavada *et al., Annals Biomed Eng*, 46(11):1844-1856, 2018.
[4] Vasavada *et al., Ergonomics*, 58(6):990-1004, 2015.
[5] Rothman *et al., J Comput Graph Stat,* 19(4): 947–962, 2010.

A survey of California grocery workers work experience during the COVID-19 pandemic: implications for policy

Constancia Dominguez [1], Anthony Pacini [2], Laura Stock [1], Carisa Harris-Adamson [1,2], Sadie Costello [1]

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Introduction: At the beginning of the pandemic, initial prevention measures were primarily focused on health care workers, but lagged weeks behind for the essential workers in the grocery industry. As the pandemic continued, minority populations, who are disproportionately overrepresented in essential services, were forced to cope with the lack of prevention measures for COVID-19 while meeting the new high demands for food access. Capturing information about the work conditions, organizational policies, and workload placed on grocery workers from both independent and chain grocery stores was important to help stakeholders understand how to further support workers since the initial shelter-in-place restrictions as they developed new policies to protect them. Therefore, the primary aim of this study was to describe the work experience and related stress on grocery workers during the pandemic.

Methods: In collaboration with researchers from UC Berkeley and the Labor Occupational Health Program (LOHP), the United Food and Commercial Workers (UFCW) sent a cross-sectional survey to grocery workers in California during the summer of 2020 to gather information about workers experiences in the workplace during the pandemic. Approximately 25,000 links to the survey were sent by text or email from union representatives of UFCW Local 5 (Northern California) and UFCW Local 324 (Southern California). During the analysis, questions were grouped by trends identified in responses pertaining to working conditions, communication of policies and their practice, work demand, psychosocial stressors, notification of COVID-19 exposures, and mental health.

Results: Overall, the survey found that grocery workers are at increased risk of being exposed to COVID-19 and are under a significant amount of stress due to the heightened job demands brought forth by the pandemic. Over half of grocery store workers have at least one medical condition that could increase their risk of becoming more seriously ill if exposed to the virus. Trying to meet these new high demands of food access, 78% of grocery workers agreed that their workload has increased a lot since the beginning of the pandemic. As a result, 70% of grocery workers reported being nervous, anxious, or on edge due to the pandemic. This stress is intensified during their everyday interactions with customers as 71% of grocery workers reported fearing for their personal safety when engaging with angry customers. Furthermore, responses concerning the implementation of a few prevention measures among grocery workers who worked at an independent versus a chain grocery store were significantly different. For example, 70% of independent grocery workers agreed that the number of customers allowed in the store was reasonable, compared to 38% of chain grocery store workers.

Conclusions: Our research provided evidence relevant to the passage of California bill AB 685 addressing the rights and protections of grocery workers during the pandemic. This bill addressed the toll on grocery workers as they try to balance their duties as essential workers in our communities, while also protecting their own health. As a result of the passage of this policy, employers are now required to notify employees of potential exposure to COVID-19 on the worksite among other provisions. Our research provides a snapshot of the burden of having to meet the demands of providing food to communities during a few months of the pandemic and it calls for further identification and evaluation of appropriate interventions to protect frontline workers within the food industry.

Risk of Particulate Dust Inhalation of Human Cadaveric Bone in a Non-Pathological Research Laboratory Environment

Students: Trevor Pugh[1], Sergei Sarkisian[1], Alec Trollan[1], and Marion Woodfield[1]
Faculty: Eric Wood[1], Kenneth L d'Entremont[1], and Leon Pahler[1]

[1] University of Utah Rocky Mountain Center for Occupational and Environmental Health

Introduction: Researchers at a laboratory that performs the cutting of human cadaveric bone raised concerns for health risks to technicians associated with aerosolized bone dust. Human cadaveric bone may contain several infectious organisms, many of which cause disease with minimal exposure concentration. No disinfectant or embalming material has demonstrated complete effectiveness in disinfecting human cadaveric bone even when suspended in materials designed to eradicate infectious pathogens. Although guidelines exist for autopsy protocols among pathologists, bone specimens investigated in the laboratory setting differ in size, shape, and composition for cadaveric bone cutting. No Occupational Safety and Health Administration (OSHA) standard or other Occupational Exposure Limits currently exist for inhalation of human bone particulate matter generated from cutting human cadaveric bone. One research laboratory has taken measures to reduce bone particulate matter by implementing cutting devices with semi-enclosed non-ventilated hoods and wet cutting methods within a ventilated room and is investigated to assess the risk of bone dust inhalation by the researcher in this process.

Methods: Particulate matter concentration measurements were collected in the research laboratory while cadaveric bone was cut and was compared to background concentrations using the GRIMM 1.109 Portable Laser Aerosol Spectrometer and Dust Monitor. The measurements were taken every six seconds by the GRIMM for five minutes while no research procedures were being performed. Measurements were then taken every six seconds for the duration of the cutting process (2.5 mins) while the researcher was sawing the skull specimen. One sampling event took place while the researcher was cutting and preparing two different skull specimens. The GRIMM was held approximately 1 foot (0.3 m) away from the cutting process at chest height while the researcher was working. The data was extracted using the GRIMM software and evaluated using spreadsheet software. Comparisons between the background concentration of particulates and concentrations while cutting the skull specimens for both respirable and inhalable fractions were performed. An independent t-test accounting for sample variance was performed using statistical significance set a priori to an α of 0.05 between the mean particulate concentration during background and cutting sample values.

Results: A significant increase (≥ 0.583 μg/m³) was demonstrated in the mean particulate value concentrations of inhalable (p-value of 0.003) and respirable (p-value of 0.007) fractions when excluding outlier particulate measurements. A significant increase in the mean particulate concentration of the respirable fraction (p-value of 0.005) including outlier values was also found.

Conclusion: Despite the wet methods, standard laboratory dilution ventilation, and protective barriers around the cutting process, significant particulate matter is generated and suspended producing potentially infectious respirable particles. This suggests that pathological grade protocols, including personal protective equipment, should be implemented in research laboratories performing bone cutting.

Evaluation of two hazardous waste storage areas at a local facility for compliance and recommendations.

Students: Ted Medina[1]; Travis Tamowski[1;] Stacy Zimmerman, DO[1]
Faculty: Eric Wood[1], Kenneth d'Entremont[1], and Leon Pahler[1]

[1] University of Utah Rocky Mountain Center for Occupational and Environmental Health

Introduction: The University of Utah OEHS Solutions course team was invited on a site visit to evaluate two hazardous waste (HW) storage areas at a facility near the Salt Lake City area that produces chemical products. The visit took place on February 2, 2021, prompted by the company's recent designation as a Large Quantity Generator, to assist with recommendations to meet regulatory compliance and to protect worker health. The first site was the Material Review Board (MRB) area located in the warehouse. The second was the high BTU room, where the employees consolidate high BTU waste from their satellite accumulation areas. The purpose of the evaluation and scope of work was to provide recommendations for appropriate HW storage, determine exposure air concentrations of VOCs to the employees while consolidating HW, provide a RCRA characterization of the consolidated HW, and create an engaging RCRA job-specific training program including videos.

Methods: On February 23, 2021, the team visited the site to conduct air sampling and monitoring and to gather samples for the RCRA characterization. Air monitoring and sampling of VOCs were conducted while the HW was consolidated into the 55-gallon barrel by an employee. NIOSH methods 1400 and 1300 were used to monitor for isopropyl alcohol (IPA) and ethanol, and acetone. Two SKC52 pumps (Q= 0.2 lpm) with 100/50mg charcoal coconut sorbent tubes were attached to the employee for personal sampling. Peak TVOC concentration was conducted with a PID with a 10.6eV lamp to measure the total concentration of VOCs which included IPA, EtOH, and acetone during the HW condensing. The RCRA characterization of representative samples was performed using the Coliwasa sampling method.

Analysis of the sampling results was used to provide appropriate recommendations for the job-specific RCRA training, process improvements including PPE, recordkeeping, and selecting an appropriate treatment, storage, and disposal facility (TSDF), along with further storage recommendations. This RCRA training will include three video presentations highlighting the importance of emergency procedures, safe practices, and compliance with regulatory standards 40 CFR 262.17 and HAZWOPER 29 CFR 1910.120.

Results: Air sampling results for acetone and ethanol were below the limit of quantification with concentrations reported under 2.6 ppm and 3.3 ppm, respectively. The IPA concentration was 5.8 ppm, which is well below the 400 ppm ACGIH STEL. Peak TVOC concentrations were measured shortly after the portable container was emptied into the HW barrel. Three peak TVOC concentrations were measured at 1) 38.5 ppm, 2) 40.5 ppm, and 3) 132 ppm. The TVOC ppm was measured using the PID calibrated with 100 ppm Isobutylene. The RCRA characterization indicated the samples only met the Ignitable D001 Criteria.

With the results and site visit observations, the team's recommendations for the high BTU room include: grounding and bonding of all barrels, dedicating the room to HW storage, installing a dedicated ventilation system, and implementing an electrical safety protocol to outlets. Our solutions also include appropriate signage for the MRB area, using tight-fitting lids on the receptacles for the storage of oxidizers and flammable HW, and dedicating a building or room for the 90-day accumulation of HW that has secondary confinement. The team recommended that weekly sign-offs are performed and posted at the entrances to the two areas.

Conclusions: After evaluating the air monitoring and sampling and due to the low exposure noted, no additional PPE requirements are necessary beyond the company's current practice of goggles, gloves, laboratory coats, and face coverings. Total VOC concentrations occurred while the employee moved away for the next portable HW container, thus limiting employee exposure. From the RCRA characterization, the hazardous waste meets the criteria for ignitability and liquid. Therefore, our recommendation is that the waste be submitted to a TSDF Vendor. Job-specific training program provided to the company will include three videos covering: 1) Safe Practices with HW, 2) Regulatory Compliance, and 3) Emergency Procedures. The format of the videos employs a scripted presentation with a voice overlay. To ensure training efficacy and engagement by the employees, important topics between the videos will overlap and quizzes will be distributed and completed by employees prior to training completion.

Hazards Assessment of a Composites Manufacturing Company

Students: Sharly Coombs[1], Andrew Gunnell[1], Alex Rytting[1], Gabriela Teniza[1]
Faculty: Kenneth d'Entremont[1], Leon Pahler[1], Eric Wood[1]

[1] University of Utah Rocky Mountain Center for Occupational and Environmental Health

Introduction: One facility for a company specializing in the design and manufacture of composite structures was assessed for health hazards. In one section of the facility, waste tanks are constructed with woven carbon fiber. Throughout the manufacturing process, there is concern for potential occupational hazards such as noise, dust particulates, and volatile organic compounds (VOCs) such as methyl ethyl ketone (MEK). Excessive occupational noise exposure is a known risk factor for noise induced hearing loss. MEK exposure can cause health effects including eye, nose and throat irritation, dermatitis, and headaches. Lastly, inhalation of dust particulates can lead to irritation, inflammation, allergies, and asthma.

Methods: Sampling was performed for noise, dust particulates, and VOCs. First, noise samples were obtained through area surveying and personal dosimetry. Area surveying was completed with a Larson Davis SoundTrack LxT1 sound level meter (SLM) throughout the facility, and personal sampling was done with 3M dosimeters on two employees in different work areas. Measurements from the Larson Davis SLM were compiled to create an isopleth map using the NoiseAtWork software. Second, dust particulates were measured using SKC AirChek XR 5000 sampling pumps and a GRIMM instrument. NIOSH Method procedures 0600 and 0500 were followed to collect a personal respirable dust and an area total dust sample, respectively, for approximately an 8-hour shift. Both dust samples were collected near a grinding process and then sent to a Bureau Veritas laboratory for analysis. A GRIMM model 1.109 portable aerosol spectrometer was used in an area where composite structures are cut. Results were downloaded to Excel and time weighted averages (TWAs) were calculated. Lastly, VOCs were measured using a MiniRAE 3000 PID and a 3M 3520 VOC passive badge. Area measurements were taken near a container of MEK using the PID. One personal sample of VOCs was taken with the passive badge using OSHA Method 1004 and then sent to a Bureau Veritas laboratory for analysis.

Results: Noise dosimetry showed that an employee in the grinding room was exposed to a TWA of 97.9 dBA, which is above the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL). An employee in the machine shop was exposed to a TWA of 74.9 dBA, which is below the OSHA PEL and action level (AL). Area noise surveying was used to create a noise isopleth map, which indicated noise levels up to 95.1 dBA in the mold assembly, 99.5 dBA in the machine shop, 80.0 dBA near the braiding machine, 86.3 dBA in the tank repair room, 92.2 dBA in the grinding room, and 87.7 dBA in the maintenance area. Results from the GRIMM instrument indicated that levels of respirable and inhalable dust in the machine shop were below the PELs and threshold limit values (TLVs). The total dust sample collected in the grinding room showed that levels were above the PEL and TLV, while respirable dust levels were below the PEL and TLV. The PID readings for MEK were below the PEL, however, work was not being done at the time of sampling. The badge used to measure MEK in the tank repair area had a TWA below the OSHA PEL.

Conclusion: As a result of the high noise levels in the grinding room, recommendations include continuation of a hearing conservation program, implementation of engineering controls to reduce noise exposure where possible and use of appropriate hearing protective devices. Due to high noise levels found during noise area surveying, noise dosimetry is recommended to determine needed abatements in the mold assembly, machine shop, tank repair and maintenance areas. In addition to the N-95 respirators already in use, controls such as local exhaust ventilation, housekeeping, and prohibiting workers from using compressed air for cleaning could help decrease total and respirable dust exposures in the grinding room. Additional sampling should be conducted after the abatements are implemented to verify effectiveness. Although GRIMM instrument results in the machine shop showed that levels of respirable and inhalable dust are not concerning, personal sampling is recommended to confirm employees' personal exposures. Lastly, the PID results indicated low levels of MEK in the tank assembly room. Since these results were collected during non-working hours, sampling should be conducted when work in the tank assembly room resumes.

Risk of Falls Among Groundskeepers Maintaining Terraces at a Public Institution

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Introduction: A group of groundskeepers working at a public institution have had several close calls with falls while at work. The employees work on terraces of varying heights above grade. The employees maintain the areas with terraces weekly to monthly. The Occupational Safety and Health Administration (OSHA) requires employers to provide a workplace free of recognized hazards, including potential falls. Severe falls are those which can cause disabling injuries or death. The severity of the injury is often correlated with the height of the fall.

Methods: The heights of ledges and drop offs at eight specific locations were measured using a marked rope. One end of the rope was dropped over the edge and the marks were counted to measure the height. To determine fall risk, Injury Severity Score (ISS) results were calculated from a regression analysis using the model of $y = 0.3558x + 3.1022$, with x = height of fall (ft.) and y = ISS. A risk assessment tool was also used to categorize fall risk. The risk assessment tool utilized a matrix based on the likelihood of a fall and the resulting injury. The ratings of likelihood and resulting injury are a Likert scale with likelihood of occurrence from almost never/rare (1) to almost certain (5) and resulting injury from minor (1) to catastrophic (5).

Results: The fall heights ranged from 5.5 feet (1.7 m) to 18 feet (5.5 m). All locations have ISS scores above the catastrophic level of 5.0 (significant risk for loss of life). Using the risk assessment tool matrix, a likelihood ranking of 5.0 was assigned to all areas due to almost certain risk of falls occurring because of at least weekly maintenance requirements. An injury prediction score of 5.0 was also chosen for all areas as they may result in death or permanently disabling injuries.

Conclusion: Groundskeeping and maintenance employees are at elevated risks of severe falls that may cause death or permanently disabling injuries. Due to the severity of the scores calculated from the regression model and risk assessment tool, the institution should implement effective measures to protect its employees from falls.

How do sleep and low back pain relate to 1-year prevalence of slips, trips, and falls among truck drivers?

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Introduction: Truck driving is the third most common occupation in the US. Truck driving is a unique occupation due to many factors, such as high physical demands and mental loads. Trucker drivers are five times more likely to slip, trip, or fall while working than experiencing a crash while working. The resulting injuries are usually costly both monetarily and in time away from work. This article builds on data previously collected in a large cross-sectional study of truck drivers by using elements from the study to examine the association between sleep and low back pain in truck driver and slips, trips, and falls.

Methods: Truck drivers (n = 817) completed a digitized questionnaire which included questions reporting demographics, psychological factors, measures of sleep quality and duration, low back pain, number of slips, trips, and falls in the past year. Drivers reported slips, trips, and falls. We use self-reported frequency of falls in the past year for both mounting and dismounting from the truck. Sleep measures include quality of sleep assessed by the question "how often do you have restless sleep," and sleep duration was assessed in half-hour increments. Frequency of low back pain when getting up in the morning was used as a metric for persistent low back pain. Potential confounders of age, gender, measured body mass index, feelings of mental exhaustion after work, depressive symptoms, alcohol use, and regular physical activity were considered. The mean and standard deviations were calculated for discrete and continuous variables. Frequency and percent were calculated for categorical variables. Crude and adjusted Odds Ratios (ORs) and 95% Confidence Intervals (95% CI) were calculated using logistic regression. An *a priori* list of potential confounders was created based on epidemiological data, biological plausibility, and prior research. An alpha level of 0.05 was used for determining statistical significance.

Table 1. Adjusted Odds Ratios associated with a 1-year prevalence of slips, trips, and falls.

How often do you have back pain in the morning		
	Always	1.86 (0.86, 4.06)
	Often	**3.12 (1.84, 5.29)**
	Seldom	**1.89 (1.22, 2.95)**
	Never	1.00 (Reference,)
Hours of sleep on the road		
	Less than 5	**2.21 (1.17, 4.17)**
	5 to 5.5	**3.76 (1.45, 9.77)**
	6.00	1.00 (Reference,)
	6.50	1.23 (0.57, 2.65)
	7.00	**2.35 (1.25, 4.45)**
	7.50	2.16 (0.99, 4.72)
	8.00	1.38 (0.72, 2.65)
	8.50	1.95 (0.83, 4.58)
	9 or more	1.49 (0.74, 2.96)
	Does not apply	1.76 (0.82, 3.79)
Restless Sleep		
	Always	1.33 (0.55, 3.22)
	Often	**2.44 (1.34, 4.44)**
	Seldom	**2.10 (1.27, 3.48)**
	Never	1.00 (Reference,)

Results: The results of the logistic regression test we performed demonstrated a meaningful association in the average amount of sleep per week, the quality of sleep, and the frequency of persistent low back pain when getting up in the morning and the 1-year prevalence of slips, trips and falls. Low numbers of hours of sleep were statistically significantly associated with having a fall. Similarly, seldom and often having restless sleep were associated with an increased risk of falls. Seldom and often having low back pain in the morning were significantly related to having a fall. These factors are all statistically adjusted for the other factors in the model and adjusted for age, gender, body mass index, mental exhaustion, and frequency of climbing in and out of the truck. Regular exercise, depressive symptoms, and alcohol use were not meaningful confounders and were not included in the final adjusted model.

Conclusions: Both sleep duration and quality of sleep have independent relationships with the increased likelihood of having a slip, trip, or fall. Similarly, persistent low back pain in the morning is a factor associated with slips, trips, and falls in truckers in this study while performing regular duties. Adjusting sleep patterns can be problematic; however, modifying sleep routines is another associated factor with slips, trips, and falls. Promotion of healthy sleep hygiene specific for commercial truck drivers may reduce slips, trips, and falls.

Rapid Trip Detection Based on Dynamic Time Warping

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Introduction: In 2016, more than 15% of the population in the US were elderly (≥65 years) and tripping is responsible up to 53% of all falls across this population. Trip-induced falls combined with improper pre-impact balance recovery are responsible for 11% of all serious injuries. To enable future trip and falls prevention strategies, it is important to study the trip detection mechanisms. Most existing studies on trip and fall detection used inertial sensors as their main data source with the fastest reported detection time of 359ms. It is important to acknowledge that most of the time detection results provided in the fall detection literature provide a pre-impact leading detection time (time elapsed from fall being detected to body hit the ground) and not a trip detection time (time elapsed from trip onset to trip detection). Therefore, the goal of this study was to develop a rapid trip detection algorithm using a single inertial wearable sensor that can detect trip perturbation faster than the human reaction capabilities (~200 ms).

Methods: Two healthy young adults with no pre-existing record of illness participated in the research. A single inertial measurement unit (IMU) with a sampling frequency of 50 Hz was attached on the lower back. The subjects were instructed to walk along a 10 m walkway with a self-selected speed. A non-stretchable rope was attached to the participant's foot and equipped with a load cell to detect trip onset determined as when the exerted force exceeded 12 N. The trip onset was introduced using solenoid-cam cleat system to restrict the leading foot during the swing phase of a gait. A total of 30 trip trials were conducted with perturbation induced at different swing phase portions. A modified version of similarity measurement algorithm called Dynamic Time Warping (DTW) was used to detect trip onset based on the lower back angular acceleration signal ($\ddot{\theta}$) in the sagittal plane, which was obtained by numerically integrating the angular velocity measurements. Collected data was post-processed and the normal walking (Q) and tripping (C) signals of respective lengths n and m were compared. To align both signals Q and C using DTW, we computed the accumulated distance between each point of both signals as $d(q_i,c_j)=(q_i-c_j)^2$ and we construct the n-by-m matrix D, where the individual elements are defined as:

$$D(i,j)=d(i,j) + \text{Min } \{D(i-1,j-1),D(i-1,j),D(i,j-1)\},$$

A fixed threshold (β) was introduced in the DTW algorithm, for trip detection purposes. The threshold was taken as the maximum value difference of the two-standard deviation (2σ) envelope obtained from normal walking trials of both subjects. Trip perturbation was detected when the accumulated distance between the warped trip signals and averaged normal walking signal surpassed the threshold value $\beta=60$.

Results: Results shows that the implementation of the DTW algorithm for signal alignment and matching with a predefined error threshold, can effectively detect trips shortly after trip onset. The algorithm successfully detected trips that were triggered at different swing phases (i.e., early 60-70%, mid 70-85%, or late trip 85-100% of gait). The average detection time for the early, mid and late trip onsets were 92.4ms, 82.9ms and 102.5ms, respectively. The elastic property of the dynamic time warping algorithm makes it possible to gauge the similarities between the normal walking and the trip signals and to locate changes in signals even when the signals do not share the same alignment, time duration, or speed (i.e., slow vs. fast walking).

Conclusions: In this abstract, a novel method for trip detection was introduced using a dynamic time warping algorithm using a fixed threshold. The average trip detection time for trips triggered at various swing phase portions was 92.6ms, which is less than the human voluntary reaction capabilities. The simplicity of the developed rapid trip detection system enables possible future integration of the system with the robotic assistive devices to provide assistance during human balance recovery in order to prevent falls and injuries.

Depression in law professionals: does physical activity really matter?

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Introduction: Literature has found that the law profession suffers from serious risks of mental health issues such as suicidal ideation, depression, anxiety and problematic drinking. However, not much has been done to better understand this occupational group's relationship with mental health concerns and substance abuse. Some of the characteristics of the job that can be averse to positive mental health include long working hours, competitive work environment, high stress and workload, little support and sedentary desk work. Thus, an interesting component lifestyle found in legal professionals is the amount of physical activity that is engaged in, and the potential relationship that it might have in depression. We believe that there will be a significant reduction in depression as the amount of activity increases engaged in by legal professionals.

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 694 person (554 lawyers) were surveyed and assessed with a questionnaire. Measures that are of focus for this article include the patient health questionnaire 9 (PHQ-9), a validated depressive symptom form, and questions asking about weekly exercise and physical activity loads. The PHQ-9 data was then dichotomized into 2 separate variables; the first was to compare no or minimal depression vs. mild to severe depression, and the second is using the pre-defined separation for diagnosis of major depressive disorder comparing no, minimal and mild depression vs moderate to severe depression. Physical activity was assessed by asking a question "During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time." and participants selecting a number of days. Mean and standard deviation were calculated for discrete and continuous variables. Frequency and percent were calculated for categorical variables. Crude and adjusted Odds Ratios (ORs) and 95% Confidence Intervals (95% CI) were calculated using logistic regression. An *a priori* list of potential confounders was created based on epidemiological data, biological plausibility, and prior research. An alpha level of 0.05 was used for determining statistical significance.

Results: Both of the analyses showed a statistically significant relationship overall between increasing physical activity and fewer responses of depressive symptoms. Table 1 presents the crude Odds Ratios and 95% . From these results, we can observe the significance in both analyses as well as a dose response for higher amounts of physical activity and less participants with depressive symptoms. These are crude findings, and analyses are ongoing to calculate Odds Ratios adjusted for confounding factors.

Table 1. Crude Odds Ratios and 95% Confidence Intervals for Relationships between Days of Physical Activity and either Mild or worse depression or Moderate or worse depression

	Mild to Severe Depression			Moderate to Severe Depression		
Physical Activity	Odds Ratio	95% Confidence Limit		Odds Ratio	95% Confidence Limit	
0 Days	**6.07**	**2.55**	**14.48**	**8.64**	**1.97**	**37.82**
1 Days	**4.55**	**1.90**	**10.88**	**4.58**	**1.02**	**20.55**
2 Days	**4.08**	**1.72**	**9.65**	3.97	0.89	17.76
3 Days	1.99	0.83	4.75	3.32	0.73	15.03
4 Days	**2.70**	**1.08**	**6.75**	4.14	0.88	19.45
5 Days	1.74	0.69	4.37	1.27	0.23	6.87
6 Days	1.18	0.44	3.17	1.68	0.31	9.16
7 Days	1.00	Reference		1.00	Reference	

Conclusions: The findings from the crude analyses of this study have shown a significant dose response relationship between the amount of weekly physical activity and fewer reports of depressive symptoms found in law professionals. Future research should be conducted in order to assess the effectiveness of implementing physical activity programs with law professionals, but these findings suggest efficacy in encouraging physical activity to those in the legal field.

Passive safety leadership, stress and firefighter safety behavior outcomes

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Introduction: Passive safety leadership has been negatively linked to safety behavior outcomes. However, this relationship is not fully understood. Beyond safety climate, this research has not fully examined mediating factors or variables that may be influenced by passive leadership, which then influence safety behaviors. Research among firefighters in this context is particularly absent. As such, this study aims to examine the relationships between passive safety leadership, stress and safety behavior outcomes.

Methods: A path analysis, using Mplus, was completed to examine the hypothesized model and posited relationships between passive safety leadership, stress and safety behaviors, including compliance behaviors, personal protective equipment behaviors and safe work practices. Cross-sectional data from 742 career firefighters and company officers were included in this study. Model fit was examined, paths were assessed for significance and an alternate model was examined to assess mediation.

Results: The hypothesized model fit was very good (X^2 = 10.89, df = 3, p = .012; CFI = .99, RMSEA = .06, SRMR = .02). Posited relationships were confirmed. Passive safety leadership was positively, significantly associated with increased firefighter stress perceptions (β = .14, p<.001). Stress was negatively, significantly associated with all three safety behavior outcomes, including compliance behaviors (β = -.19, p<.001), personal protective equipment behaviors (β = -.18, p<.001) and safe work practices (β = -.28, p<.001). The alternate model, which included added direct paths from passive safety leadership to the behavior outcomes illustrated that full mediation occurred as the direct paths from passive safety leadership to the behaviors were not significant, while the paths from stress to the behavior outcomes all remained significant (p<.001).

Conclusions: Passive safety leadership profoundly influences firefighter stress perceptions, with increased stress perceptions resulting in negative safety behavior outcomes. These data identify a notable relationship between passive safety leadership and stress and emphasize the need for future research to explore why stress causes the safety behaviors of firefighters to diminish. This study also underscores the importance of developing active leaders within the fire service to minimize leadership as a stressor and to ensure these imperative behaviors do not decline with potentially catastrophic results.

Examining employees' intention to evacuate during a fire alarm in a university workplace setting

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Introduction: Non-residential fires and resultant injuries and deaths have been on the rise the last decade in the U.S. Although evacuation is a primary prevention method to prevent injury or death, people in the workplace still fail to evacuate when they hear a fire alarm. This study applied the Reasoned Action Approach (RAA), a theory of behavior focused on belief determinants, to examine factors related to employees' intention to evacuate the next time they heard a fire alarm at work. Extant literature supports that intention to perform a behavior is a strong predictor of behavior. The RAA has been utilized in other domains of health to predict intention to perform a behavior but is underutilized in occupational health research.

Methods: Data were collected from employees at a large public university in the Midwest (N=490). A multiple regression analysis was performed to examine the relationships between intention, attitude toward the act, perceived norm, and perceived behavioral control while controlling for age, gender, race/ethnicity, education level, and faculty status.

Results: Multiple linear regression results ($F(14, 475)=41.30$, $p<.001$, $R^2=.536$) suggest attitude toward the act ($B=.162$, $p<.001$) and perceived norm ($B=.639$, $p<.001$) were significantly associated with intention, with perceived norm having a greater weight on intention.

Conclusions: Results from this theory-based study suggest worker attitudes and perceived norms impact intention to evacuate for fire alarms. These findings provide direction for those managing workplace safety and emergency management activities, including the design of interventions to bolster evacuation to curtail injuries and fatalities related to fires.

Work-related Amputations in the California Workers' Compensation System

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Introduction: Work-related amputations result in some of the highest medical costs and most lost workdays of any work-related injury. There is limited person-level information regarding amputations in the workplace and information that is available is often flawed or incomplete. To provide a more detailed view of amputations in the workplace, we investigated person-level de-identified workers' compensation claims from the state of California from 2007-2018. California represents the largest state economy and has the largest civilian workforce in the United States.

Methods: We obtained di-identified workers' compensation claims data from the California Department of Industrial Relations Worker' Compensation Information System for the years 2007-2018 for all persons that had an ICD-9/10-CM diagnosis code, or an ICD-9/10-CM/CPT procedure code related to an amputation. We extracted demographic and descriptive information about the study population from the claims data. We calculated annual incidence for total amputations as well as stratified by amputation level. To characterize the experience of injured workers following an amputation, we correlated medical costs to lost workdays. Finally, to investigate what factors influence medical costs, we used a quantile regression analysis to determine what variables significantly impact medical costs within the first year.

Results: 16,931 claims were identified as having a work-related amputation. The study population had a median age of 42 years and was comprised mostly of males (84.8%) that had a median annual salary of $31,200 and were primarily full-time employees (71.7%). The 12-year average incidence was 8.9 (8.5-9.4) amputations per 10^5 workers, and the year with the highest incidence was 2008. The industries with the highest incidence were construction with 26.0 (22.4-30.0) claims per 10^5 workers followed closely by manufacturing that had 25.9 (23.3-28.9) claims per 10^5 workers. Total medical costs were overall moderately correlated with total lost workdays (Spearman's rho=0.53). The strength of correlation decreased as amputation severity increased, indicating that more severe amputations resulted in lost workdays after medical spending had ceased. Factors that significantly impacted medical costs within the first year following injury were the year of injury, the time to amputation, the use of a prosthesis, the presence of legal action, the medical intensity in the first month, and the medical complexity of the initial injury.

Conclusions: Investigation of person-level claims data indicated a higher incidence rate, higher medical costs, and more lost workdays than what has been previously reported. The results we report can inform clinicians and policy makers in their efforts to manage this population and focus efforts on high-risk industries to reduce the incidence of work-related amputations.

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Assessing a relationship between Burnout and drug use disorder among Lawyers

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Introduction: Lawyers are an integral part of our functioning society. Lawyers face multiple challenges to their mental health; long hours, stressful situations, dealing with criminals. The sparse research on lawyers reports that they have high rates of depression, anxiety and alcohol use disorder compared to other working populations. Other reports suggest that lawyers have relatively high rates of suicide attempts. There are relatively few studies evaluating the prevalence of poor mental health and potential associated factors. A prospective cohort study was undertaken to quantify the prevalence of poor mental health symptoms and associated factors, including substance abuse, chronic diseases, and work-related factors, among practicing lawyers. This is an analysis of baseline data collected prior to the COVID-19 pandemic.

Purpose: This study aims to quantify the association between burnout as measured by a previously validated burnout scale and a measure of substance abuse using the modified DAST10 in law professionals, after adjusting for potential confounders.

Methods: This study was approved by the University of Utah Institutional Review Board. After obtaining Informed consent eligible participants completed a computer-administered questionnaire, which took approximately 5 minutes. This questionnaire collected data regarding depression, anxiety, burnout, engagement, problem drinking and drug use. Other factors include type of law, hours of work in an average week, age, self-reported height and weight, and other potential confounders. Drug use was assessed using 3 questions from the DAST 10 assessment. These three questions were decided upon based on prior literature and time constraints. Burnout was assessed using 2 questions from the Maslach Burnout Inventory, 1 item from the domain of emotional exhaustion and 1 item from depersonalization. Mean and standard deviation were calculated for discrete and continuous variables. Frequency and percent were calculated for categorical variables. Crude and adjusted Odds Ratios (ORs) and 95% Confidence Intervals (95% CI) were calculated using logistic regression. An *a priori* list of potential confounders was created based on epidemiological data, biological plausibility, and prior research. An alpha level of 0.05 was used for determining statistical significance.
Results: There were 756 participants, age of 48.44 ± 12.48 years, mean BMI of 28.16 ± 9.89 kg/m2. The study consisted of 57% male participants (N=436). Based on preliminary data, the results of a logistic regression there is a statistically significant relationship between burnout and the modified Dast10 outcome variable. According to the results of an adjusted logistic regression, if you had a positive score on the DAST10, meaning if you have used any illegal drugs, you are 2.07 times more likely to have experienced BURNOUT, (p=0.00075 OR =2.07, 95% CI 1.215 – 3.542). Conversely, if you had a positive score for BURNOUT, you are 1.13 times more likely to have used drugs, after adjusting for age, gender, and BMI (p=0.0008 OR =1.13, 95% CI 1.05-1.22). Additionally, Engagement may play a protective role in the outcome of modified DAST10. If you had a positive engagement score you were 0.889 times more likely to have used illegal drugs (OR=0.889, 95% CI 0.817 – 0.966)
Conclusion: Preliminary results show that there is a relationship between burnout and modified DAST10 when adjusting for age gender and BMI. If risk factors of BURNOUT can be identified as well as potential psychosocial factors that have a positive effect on mental well-being, it would decrease the amount of drug use among law professionals and potentially increase overall mental well being in law professionals

Perceived COVID-19 challenges among fire-based first responders

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Introduction: Mental health among first responders is a growing area of concern and movement. In 2018, SAMHSA reported that around 30 percent among first responders would develop behavior health conditions compared to 20 percent in the public. The risk of mental health issues increases during and after states of emergency or disaster. The emergence of the COVID-19 pandemic created greater pressure for an already strained first responder system. Seeing the need and the opportunity for assessment, The Center for Firefighter Injury Research and Safety Trends (FIRST) at Drexel University received funds to merge two of their ongoing projects to create an in-depth mental health assessment to gauge the psychological impact of COVID-19 on fire-based first responders during the first wave of the COVID-19 pandemic. Preliminary findings from the COVID-19 RAPID Mental Health Assessment (RAPID) indicated increases in burnout, anxiety, depression, and intention to leave the profession, decreases in job satisfaction, work engagement, and organizational support. The top 5 responses to how the pandemic was impacting first responders were: fear of spreading the virus to family/friends, change in eating patterns, change in sleeping patterns, required by work to quarantine, and lack of access to PPE. To better understand the reported physical and emotional challenges faced by fire-based first responders, qualitative data depicting firsthand accounts of the fire department's challenges during this time are needed. The purpose of this study was to dig more deeply into the experiences of firefighters during the pandemic by performing structured interviews with affected participants, allowing them to recount their experiences during the COVID-19 pandemic.

Methods: Semi-structured interviews and focus groups were conducted with 15 out of the 20 fire departments participating in RAPID. The 10 focus groups and 5 interviews occurred during the final two months of the RAPID assessment between September and October of 2020. After the data was transcribed and organized, thematic analysis occurred to identify key themes. Following best practices for qualitative data analysis, agreement between coders was tested for each question until the coders had a .85 kappa value or higher. Data analysis is ongoing but will be completed and shared at the upcoming conference. Analysis results tables will be created to display the occurrence of each theme.

Results: We expect the emergence of themes to indicate fire-based first responder perception of where the department's strengths and weaknesses lie to adapt to change and support members during the extended emergency of the global pandemic. We expect to see high prevalence of challenges surrounding information processing, operational changes, compliance, and childcare concerns. We expect a high prevalence of department support surrounding personal protective equipment (PPE), time-of, and inter-member support.

Conclusions: The results will provide important, rich insights into the experiences of fire-based first responders during the COVID-19 pandemic. Further, given the results mentioned from the quantitative assessments, the findings to be shared here will help further explain the variability found with the COVID-19 RAPID Mental Health Assessment.

Association between major depressive disorder and work and personal factors among Utah lawyers

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Introduction: There are approximately 1.3 million lawyers in the US, in a variety of fields including civil and criminal litigation or defense and transactional law. They play a key role in building and protecting the justice of society. In 2013, there were approximately 7,840 lawyers who are active and resident of Utah, approximately 27 lawyers per 10,000 resident, and the Utah State bar has more than 10,000 members in 2020. The well-being of lawyers is of great interest to their employers, clients, and society as a whole. The practice of law is competitive and requires a high degree of concentration and mental functioning. If lawyers are not mentally healthy, they cannot provide the legal service needed by their clients. Additionally, their ethics and professionalism may suffer. Depression is a concern among lawyers. Work-industry factors such as hours work and individual behavioural factors such as drinking habits and drug abuse may be a reflection of one's depressive state. We are interested in exploring the relationship between major depressive disorder (MDD) and these work-industry and personal factors, specifically, hours work, alcohol consumption and drug abuse. If an association between MDD and any of these factors are found, the result can be used to modify the mental health program currently offered to lawyers to increase its effectiveness in treating MDD.

Methods: The cross-sectional study was conducted by Rocky Mountain Center for Occupational and Environmental Health to assess the well-being of law professionals and law students. The survey focused on the questions such as work environment, personal medical histories, and activities to understand their contribution to depression, anxiety and alcohol/substance abuse. The data were collected from fourteen law firms and individual practitioners in Utah, with intention to address multiple hypothesis. Only the observations pertaining to lawyers are analyzed (N=566) for this manuscript. Three recruitments methods were implemented and analyses demonstrated statistical equivalence between the three methods. The effect of frequency of alcohol consumption, drug abuse, and hours work were chosen as the primary covariate of interest and their impact on major depressive disorder are explored. Various models including crude models to testing the effect of confounders and multiple covariate models were investigated using logistic regression. Age as an effect modifier between hours work and MDD was tested. Lastly, the effect of interaction between age and BMI was tested in the final multiple covariate model. Odds Ratios (OR) and 95% Confidence Intervals (95% CI) were calculated using R programming language.

Results: In the final multiple covariate model, the OR of drug abuse was 2.59 (95% CI: 1.26-5.32), working between 51-50 hours/week was 2.80 (95% CI: 1.09-7.23), and working >60 hours/week was 3.58 (95% CI 1.13-11.34). associated with MDD. Frequency of alcohol consumption is not statistically significantly associated with MDD. Drug abuse was statistically significantly associated to MDD in all models fitted. In the crude model, the OR and 95% CI were 2.20(95%CI: 1.07-3.41), 2.07(95%CI: 1.10-3.90) in the model including clear cut confounders, and lastly, 2.19(95%CI: 1.15-4.17) in the model including all confounders. There was consistently increasing pattern of ORs as hours work increased. Age served as an additive effect modifier between hours work and MDD. Including age resulted in removal of statistically significant association between hours work and MDD. That is, the p-value of hours work in the model all exceeded 0.05. However, the increasing trend in OR over increasing hours work still remained. Interaction between age and BMI was not significant.

Conclusions: We were able to find that drug abuse and working many hours (more than 50 hours per week) significantly increases one's odds of being diagnosed with major depressive disorder. Therefore, it is advised that the law firms and employers of lawyers implement health program focused on mental well-being of lawyers, especially for those who tend to work more than 50 hours per week or those who have been progressively working longer hours. In promoting receiving mental health care, we recommend that the advertisement include invitation for those who have had previous history of drug abuse, since this information is mostly likely not available to the employers.

Personal and work-related risk factors and protective safety resources associated with musculoskeletal disorders among stone, sand and gravel mining industry workers: perspectives from management.

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Introduction: Musculoskeletal disorders (MSD), which are associcated with adverse health outcomes and negative financial implications, are very common in many industries, including the stone, sand and gravel mining (SSGM) industry. There is a need for research into the etiology of work-related MSD in SSGM with the aim of reducing and eliminating these disorders.

Methods: In this study, a focus group comprised of management professionals working in SSGM organizations was conducted to gain their insights into risk factors associated with MSD including personal factors, work factors and job demands. In addition, safety resources that may help prevent MSD were also identified. The focus group session was recorded and the transcript was analyzed using Deductive Content Analysis, which was completed by three study team members.

Results: Demographic/personal factors associated with MSD included worker age, experience, physical fitness and attitudes. Work factors/job demands identified included excessive lifting, performing additional job duties beyond the normal scope of work and work duties related to maintenance and equipment operation. Identified safety resources that may help curtail MSD were fitness for duty, good pay and benefits, equipment and resource adequacy, the SLAM (Stop, Look, Analyze/Assess, Manage) process and a positive safety culture.

Conclusions: MSD in the mining industry are influenced by a myriad of factors as evidenced by the findings of this study. A focus on addressing these factors through a collaborative approach involving mine workers and management may help to reduce / eliminate the incidence of MSD thus improving the health and safety of workers. Utilizing the safety resources identified in this study may also result in the added benefit of increased worker satisfaction and positive safety climate, both of which have been associated with better overall worker safety and business performance.

Effectiveness of Ergonomic Intervention in Work-related Postures and Musculoskeletal Disorders of Call Centre Workers: A Case-control Study

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Introduction: Improper posture, inadequate workstations, and prolonged computer use are established risk-factors of musculoskeletal disorders (MSDs). It has been found that following ergonomic intervention increases workers' office ergonomics knowledge and awareness and can lead to a significant decrease in self-reported MSDs. The objectives of this study were to measure the level of self-reported MSDs of call center workers and determine the effectiveness of an ergonomic intervention on their posture and MSDs symptoms.

Methods: We conducted a case-control study among 32 call center workers from Cebu and Manila Philippines for four weeks. Ergonomic intervention on posture and workstation was provided to the experimental group. The contents were adapted from a European Council directive used in a previous study. We utilized rapid upper limb assessment (RULA) and rapid entire body assessment (REBA) as primary outcome measures and body part discomfort (BPD) questionnaire as a secondary outcome measure. Wilcoxon signed-rank tests were performed within groups to determine significant differences in scores of RULA, REBA, and BPD ($P \leq 0.05$).

Results: The RULA mean score of the experimental group for Manila decreased from 4.3 to 1.4. For Cebu, it reduced from 3.6 to 1.6. After the intervention, the Manila group had a total reduction in REBA score of 5.9 and the Cebu group had a decrease of 6.2. However, there was no significant difference in the perceived body pain (BPD) of workers before and after the intervention except for the mean body part discomfort frequency (BPDF) (P 0.028) and body part discomfort frequency severity (BPDFS) (P 0.017).

Conclusions: The ergonomic intervention was effective in correcting postures of study participants but unable to improve the prevalence of MSDs symptoms. Further studies are recommended following a longer duration of intervention and provision of ergonomically-designed equipment and workstation.

Industrial Hygiene Evaluation of Selected Hazards in Composite Fiber Manufacturing Operations

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Introduction: The manufacture of composite materials includes several processes that carry inherent risk of occupational illness and injuries. Our team was invited to evaluate some process specific risks, to ensure adequate safety measures are being employed. Specifically, we evaluated noise and dust levels in the areas most prone for those hazards. Exposures to TWA noise levels in excess of 85 dBA are known to cause NIHL and contribute to worker fatigue and accidents. Particulate matter (dust) exposures are regulated by OSHA to a PEL of 15 mcg/m3 for total dust and 5 mcg/m3 for respirable dust. Exposures over these thresholds put the workers at risk of lung disease and various systemic diseases. We also measured the workers' exposures to volatile organic compounds (VOCs) during work that requires significant use of MEK as a solvent. MEK can be irritating to the eyes and respiratory tract and is a potential cause of liver and kidney damage.

Methods: Sampling was performed over a two-day period attempting to measure each exposure at the anticipated maximum levels. Noise sampling was completed using a Larson Davis SoundTrackLxT in a 10ft grid pattern in the machine shop to construct an isopleth map of the room. Additional noise measurements were taken at specific workstations over 30 second intervals to evaluate short term levels during periodic use of the loud equipment. A GRIMM particle counter was used to measure dust levels in an area of the facility where sanding is completed. The GRIMM measured samples every minute for the duration of a work shift. Data was analyzed with the GRIMM spectrometer to identify the size and amount of the particulate matter. VOCs were evaluated with 3M 3500 passive badges worn by painters. Active sampling for VOCs during epoxy application and painting prep was conducted using a Rae Systems MiniRae 3000 Photo Ionization Detector. The VOC levels measured will be compared against ACGIH STEL and OSAH PELs for MEK.

Results: A noise survey in the machine shop during operations showed an exposure of up to 84 dBA. The maximum noise areas during operations were the technician's work stations, subsequent measurements away from the machines reduced noise to below 80 dBA. Additional machine shop tasks were also evaluated for noise exposure and included operation of a band saw (103.5 dBA), pneumatic sander (97.8 dBA), and drill press (86.2 dBA). Dust monitoring in a sanding booth showed a total dust exposure of 0.073 mg/m^3 and respirable dust of 0.052 mg/m^3. VOC surveying for MEK found that solvent wipes used during the application of edge sealant showed a maximum worker exposure of 290 ppm. Painters were monitored for MEK and were found to have a maximum exposure of 0.55 ppm.

Conclusion: The Isopleth Map shows that all areas of the Machine Shop were below the ACGIH TLV and the OSHA PEL. The areas where the noise was at its highest, were the areas where the workers stood to operate the smaller machines in their workstations. Workers need to be instructed on the importance of hearing protection while operating machines. Dust monitoring results indicated that worker exposures were below the OSHA PEL and that the ventilation system was operating effectively. The VOC exposures during the edge seal and paint area were well below the required limits for both short term and full day exposures, however, the engineering controls that are currently in place could be utilized more effectively.

Occupation and Relation to Lung Cancer Recurrence and Overall Survival in the Boston Lung Cancer Survival Cohort (BLCS)

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Introduction: In the United States (U.S.), lung cancer is the leading cancer-related killer in the population. Many patients with lung cancer, after undergoing treatment, develop recurrence and die of their disease despite curative resection. There is ample scientific evidence that occupational exposures, such as asbestos, is associated with an increased risk of lung cancer, yet more research is needed in relation to the risk of lung cancer recurrence after successful treatment. Even with successful treatment and/or surgery, lung cancer survivors still suffer from a high relapse rate, likely due to retain carcinogen in the lung. Occupational health, safety, and hygiene all play an essential factor in affecting the risk of lung cancer recurrence. Our goal is to study which occupations may increase the likelihood of lung cancer recurrence in patients. Specifically, we aim to address the association of various occupations on risk of lung cancer recurrence. Our aim is to explore potential factors for future intervention in the workplace environment. Primarily, our goal is to identify the target workforce that may be disproportionately affected by lung cancer recurrence, and hopefully propose acceptable and cost-effective measures to address it. In this abstract, we describe our methodology.

Methods: The BLCS is a hospital-based cancer epidemiology cohort, utilized for risk and survival of lung cancer information established by Dr. Christiani and supported to date by research projects at Harvard T.H. Chan School of Public Health (HSPH). Since 1992, over 14,000 lung cancer cases have been enrolled from Massachusetts General Hospital (MGH) and the Dana-Farber Cancer Institute (DFCI), Boston, MA. The existing BLCS cohort was maintained for the purpose of supporting the DF/HCC Lung Cancer Program, and were administered questionnaires regarding their demographics and occupation. To assess occupational exposures, patients were asked to report occupations (ex: power plant workers, auto mechanics, shipyard, insulators) that involved exposure to asbestos, PAH, or other lung carcinogens. To assess exposure, we will use a job exposure matrix (JEM) to assign exposure estimates in the cohort. Furthermore, the research team collected health information and samples from lung cancer patients during their follow-up visits, which will be used to discover and validate time of tumor recurrence and time and causes of death,as well as overall survival. A trained BLCS statistician provides comprehensive statistical support for the BLCS infrastructure, including oversight of all analyses, statistical programming, quality control and software to ensure best analyses. Analyses will always begin with exploratory data analysis and cox models and logistic regression models will be used.

Results: Pending.

Conclusions: The overall aims will focus specifically focus on identifying and evaluating the relationship between occupation and lung cancer recurrence and overall survival. Our goal is to identify a workforce that may be disproportionately affected by lung cancer recurrence after curative therapy.

Safety Sign Comprehension of College Students

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Introduction: Safety signs are essential to convey information about potential hazards at workplaces. If they convey the message correctly, they can prevent occupational accidents and illnesses. The effectiveness of a safety sign is dependent upon the design of the sign, environmental work conditions, and the characteristics of the individual interacting with the sign. It was hypothesized that providing properly designed safety signs will enhance the effectiveness of safety signs. The purpose of the current study was to determine the level of safety signs comprehension of senior engineering students in Turkey.

Methods: An online questionnaire survey was provided to 188 senior engineering students to investigate their comprehension. Almost half of the students (48.4%) had never been received training on health and safety signs before they participated to the study. Subjects were asked to indicate the meaning of 22 safety signs (5 prohibition signs, 5 mandatory signs, 5 warning signs, 1 fire equipment and fire action sign, and 6 safe condition and first aid signs) by choosing one label among 4 alternatives. Graphical symbols were based on the ISO 7010 standard and displayed in color.

Results: Out of 22 questions, 5 questions were answered correctly by less than 50% of the subjects and 12 questions were answered correctly by less than 70% of the subjects. The overall performance of safety sign comprehension was 65.9% (std. dev. 26.2%); the performance of prohibition signs was the highest (91.6%) and warning signs was the lowest (49.9%). The least three comprehension performance was related to three warning signs: 17.7% for “toxic material” (W016), 26.6% for “automatic start-up” (W018), and 30.3% for “overhead obstacle” (W020). The highest three comprehension performance was related to the sign of “connect an earth terminal to the ground” (M005) (95.6%), “evacuation assembly point” (E007) (98.4%), and “do not use lift in the event of fire” (P020) (100%).

Conclusions: Safety signs are vital communication tools for accident prevention, fire protection, hazard communication, and emergency evacuation. However, the results of the current study indicate that some safety signs may not convey clear messages to employees who were supposed to understood the meaning of the sign and behave accordingly. To improve the comprehension performance, safety signs may be redesigned and/or employees may be trained properly.

FMCSA seizure study

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Introduction: Single seizures, epilepsy, and other seizure disorders affect an approximate 0.5% of the world's population, with about 2 million individuals in the United States. People with seizure disorders have a three-fold increased risk for death and is associated with increased risk for motor vehicle accidents (MVA). Epilepsy is associated with visual and cognitive impairment and is hard to treat due to harsh effects from anti-epileptic drugs (AEDs) which can also cause cognitive impairments and neuropsychological function effects after undergoing epilepsy related surgeries which can lead to lifelong defects. However, many of these effects greatly depends on the type of seizure the person has such as absence seizures, myoclonic seizures, tonic and atonic seizures and tonic-clonic seizures. Based on the type of seizure someone has they may be treated in different ways such as surgeries or AEDs. Commercial drivers with a diagnosed seizure disorder have strict regulations regarding their ability to drive. These regulations were created many decades ago. Moreover, workers in safety-critical jobs, including all modes of transportation, forklift drivers, crane operators, machine operators, and others are at increased risk of injury to themselves and others if they suffer a seizure while on the job. We undertook a comprehensive systematic literature review to identify all published peer-reviewed articles assessing relationships between seizure recurrence following a prior seizure of different types and treatments.

Methods: We conducted a broad and comprehensive systematic literature reviews to identify all high- and moderate-quality original research studies. Medical Subject Heading (MeSH) Terms were be used to identify studies relevant to the tests, treatments and diagnoses in question. A combination of MeSH terms and other terms were used in order to determine the method that will yield the most relevant studies in the search process. We will search 5 databases; Google Scholar, PubMed, CINAHL, Scopus, and The Cochrane Central Register of Controlled Trials. Articles were graded for quality based upon objective scoring tools. Our study questions were to assess the risk of a recurrent seizure following 4 separate seizure scenarios;

1. What is the risk for seizure recurrence after an unprovoked first seizure in adults at each year up to 10 years following the first seizure for individuals who (a) are treated with antiepileptic drugs, and (b) are not treated with antiepileptic drugs?

2. What is the risk for seizure recurrence after a provoked first seizure in adults at each year up to 10 years following the first seizure for individuals who (a) are treated with antiepileptic drugs, and (b) are not treated with antiepileptic drugs?

3. What is the risk for seizure recurrence after a diagnosis of a seizure disorder, to include epilepsy, at each year up to 10 years following the diagnosis for individuals who (a) are treated with antiepileptic drugs, and (b) are not treated with antiepileptic drugs?

Results: In this study there were 25 articles identified that we related to identifying relationships between crashes among drivers with epilepsy and seizures. These articles were summarized with objective quality scores. The scores will resemble a baseline for how effective a treatment is for the seizure being examine within the article. Quality scores and summary of the literature will be presented.

Conclusions: The articles that were researched will help with a basic understanding of how effective certain treatments are for different types of seizures. The scoring of these articles creates a general idea of which treatments are better for different types of seizures. These data will provide risk estimates for seizure recurrence at different time points given the prior seizure scenario. This can help inform policy for the acceptable risk for workers with a history of seizure employed in different industries and performing different safety-critical jobs.

Do Anti-Fatigue Industrial Insoles Affect Static Balance?

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Introduction: The aging workforce presents unique challenges and many opportunities for technology advancement in health and safety. Although less likely to have workplace accidents, older workers are more prone to serious or fatal injuries. In certain environments, such as warehousing, anti-fatigue mats and compliant flooring, which may reduce fall injury severity, may not be feasible due to the use of heavy machinery that would compromise their effectiveness. As an alternative to floor mats, anti-fatigue insoles may reduce fall incident rates, especially for at-risk populations, by facilitating greater balance awareness. While strides have been made to identify singular characteristics that may improve balance, such as rigid foam arches and 3D patterning, there is a deficit in research examining the characteristics of insoles with potential balance-modifying characteristics. Because they incorporate texturing and/or arches, three pairs of industrial insoles were studied to investigate balance-enhancing properties that could assist aging workers. We hypothesized that an insole with a fully textured bottom would most significantly improve static balance compared to other insoles.

Methods: Full-body kinematic and kinetic analyses for twenty individuals will be performed. A full body marker set, motion capture system, and a raised platform with six force plates will be used to record motion and ground reaction force (GRF) data for static balance assessments. Pilot data for 5 participants (3 female, 2 male) are presented here. Static trials required the subject to remain as still as possible while standing on two force plates, one for each foot. Each individual trial lasted 30 seconds, and the participants were asked to keep their eyes closed or opened and fixed on a target located on the opposing wall. Each condition was repeated three times for a control (no insole) and the three insole styles. Data were processed in Visual3D. The combined center of pressure (COP) and their mediolateral (ML) and anterior-posterior (AP) excursion ranges were obtained.

Results: The resulting COP values were reported as a proportion of an insole trial's ML or AP range relative to its corresponding control. A reduction in the excursion range, in the AP direction, was observed for the means of each experimental condition, represented by a proportion of less than 1.0. This trend was apparent for all insole styles during both the eyes-open (EO) and eyes-closed (EC) conditions. A more pronounced decrease in range was observed during the EC conditions for all insoles. Pair A, which consists of a rigid EVA foam top and compliant texturing on the bottom, instigated the largest proportional improvement on balance during EC (0.786+/-0.816). Pair C, with an arched EVA foam top and two sections with texturing on the bottom, improved EO AP balance (0.821+/-0.909) most substantially. While the ML ranges were reduced, they had significantly larger standard deviations, where Pair C had instigated the largest proportional EC decrease (0.943+/-1.348), and Pair B facilitated the largest EO improvement (0.844+/-3.875). During static balance, decreased ML and AP ranges of COP excursion are indicative of enhanced stability. In addition, vision is an essential part of maintaining postural control. It is supposed that, when visual feedback was removed, Pair A provided the greatest tactile feedback due to the 3D texturing. Thus, all insole styles improved the static stability of the pilot test participants on average, even when visual feedback was removed. The current results are in favor of our hypothesis and may signify that insoles with texturing and/or arch support can improve static balance. Additional research is planned to confirm these findings, incorporate center of mass (COM) measurements, and verify the balance performance changes observed in this pilot work for older adults.

Conclusions: As the workforce ages and their physical capabilities change, it is important to provide technologies that enhance worker safety and wellbeing. Although often analyzed for those with known balance impairments, insoles may improve tactile feedback and postural control of otherwise healthy workers. This in turn would enable workers to maintain balance in response to changes in floor surfaces and other causes of balance perturbations that may lead to workplace injury, reducing the chances of a fall from occurring in the first place. Moreover, these insoles may also provide anti-fatigue benefits and should be a subject of future work.