24th Pilot Research Project Symposium

OCTOBER 12-13, 2023

PROGRAM BOOKLET

University of Cincinnati Education and Research Center (ERC) Supported by the National Institute for Occupational Safety and Health (NIOSH) Grant # T42-OH008432

Contents

About the ERC and PRP

Welcome to the University of Cincinnati Education and Research Center's (ERC) **24th Annual Pilot Research Project (PRP) Symposium** on October 12-13, 2023 held at the University of Cincinnati, Kettering Lab Complex. The purpose of the PRP is to increase the research capacity of research trainees and young investigators in occupational health and safety and to encourage those in related disciplines to pursue occupational health and safety research.

Under the administrative direction of Dr. Amit Bhattacharya and Dr. Gordon Gillespie, research proposals are solicited and peer-reviewed annually by qualifying faculty and graduate students from the **University of Cincinnati and the following PRP partnering institutions – Air Force Institute of Technology, Bowling Green State University, University of Toledo – Health Science Campus, Central State University, Purdue University, University of Kentucky, Western Kentucky University, Eastern Kentucky University, Murray State University, Ohio University and Kentucky State University.**

At this symposium, the 2022-23 awardees will be presenting the results of their research and the 2023-24 awardees will make poster presentations of their proposed work. The keynote speaker is **Dr. Sergey Grinshpun, Professor Emeritus at the University of Cincinnati, presenting on "Respiratory Protection: Lessons Learned from the COVID-19 Pandemic and Beyond."**

The University of Cincinnati's Education and Research Center is one of 18 national centers funded by the National Institute for Occupational Safety and Health (NIOSH). Dr. Amit Bhattacharya serves as the director of the ERC, which is based in the University's Department of Environmental and Public Health Sciences within the College of Medicine. The purpose of the ERC is to train professionals in the didactic and research skills necessary to lead in occupational safety and health disciplines. Results of research are translated into action through an outreach program and shared with professionals and practitioners in the region via continuing education.

Since 1999, the PRP program has allocated over $1.68 million to support 281 pilot research projects. These projects have served as a catalyst in bringing over $43 million in additional research support to the region from sources independent of the PRP program, such as, the National Institute for Occupational Safety and Health (NIOSH), National Institutes of Health (NIH), United States Department of Agriculture (USDA), National Science Foundation (NSF), and the Centers for Disease Control and Prevention (CDC). Additionally, the PRP has brought 66 new investigators from other fields of expertise to the area of occupational safety and health research.

2023 Pilot Research Project (PRP) Symposium
University of Cincinnati NIOSH Education and Research Center
October 12-13, 2023
University of Cincinnati, Kettering Lab Complex

Thursday, October 12, 2023

1:00pm – 5:00pm	**Careers Workshop** *Kettering Lab, 121*	Lab tours and Q&A meeting with current ERC graduate students. Workshop is for students interested in learning about and pursuing UC ERC graduate programs.
6:00pm – 8:00pm	**Welcome Reception** *Kettering Lab Atrium & Lobby*	

Friday, October 13, 2023

7:30am	**Registration & Breakfast** *Kettering Lab Lobby*	
8:00am	**Welcoming Remarks** *Kehoe Auditorium*	Alex Lentsch, PhD, Sr. Associate Dean and Chair of the Department of Environmental and Public Health Sciences
8:05am	**Introduction of Education and Research Center & Pilot Research Project Program** *Kehoe Auditorium*	Amit Bhattacharya, PhD, CPE, ERC & PRP Program Director *University of Cincinnati, Environmental and Public Health Sciences*
8:10am	**Factors and Strategies Influencing Chemotherapy Safety among Oncology Nurses** *Kehoe Auditorium*	Dania Abu-Alhaija *University of Cincinnati, College of Nursing*
8:30am	**Carbon Nanotube-based Thermoelectric Fabrics Providing Thermal Comfort and Power Generation for Firefighters** *Kehoe Auditorium*	Je-Hyeong Bahk *University of Cincinnati, Mechanical and Materials Engineering*
8:50am	**Evaluating Microbiome as Biomarkers in Firefighting Associated Stress** *Kehoe Auditorium*	Sukanta Bhattacharya *University of Cincinnati, Environmental and Public Health Sciences*
9:10am	**Flexible and Wearable Supercapacitors for Fire Fighters and First Responders** *Kehoe Auditorium*	Kavitha Joseph *University of Cincinnati, Mechanical and Materials Engineering*
9:30am	**Poster Session 1 & Break** *Kettering Lab Atrium & Lobby*	2023-24 PRP Awardees and Other Invited Poster Presenters
10:10am	**Introduction of Keynote** *Kehoe Auditorium*	Amit Bhattacharya, PhD, CPE, ERC & PRP Program Director *University of Cincinnati, Environmental and Public Health Sciences*
10:15am	**Keynote Presentation** **Respiratory Protection: Lessons Learned from the COVID-19 Pandemic and Beyond** *Kehoe Auditorium*	Sergey Grinshpun, PhD *University of Cincinnati, Environmental and Public Health Sciences*
11:00am	**Multi-sensor Occupation Specific Energy Expenditure Models for Race Riders** *Kehoe Auditorium*	Michaela Keener *University of Kentucky, Rehabilitation and Health Sciences*

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11:20am	**Evaluating Stress and Wellbeing Trends in U.S. Correctional Nurses** *Kehoe Auditorium*	Elizabeth Keller *University of Cincinnati, College of Nursing*
11:40am	**Nitrogen-doped Three-dimensional Graphene as Sensor for Heavy Metals** *Kehoe Auditorium*	Mahnoosh Khosravifar *University of Cincinnati, Mechanical and Materials Engineering*
12:00pm	**Networking Lunch & Break** *Kettering Lab Atrium & Lobby*	
1:00pm	**Cool Helmet for First Responders Based on Nano Carbon Composite and Thermoelectrics** *Kehoe Auditorium*	Kyle Brittingham on behalf of Vamsi Kondapalli *University of Cincinnati, Mechanical and Materials Engineering*
1:20pm	**Real-time Lifting Risk Prediction Using Tactile Gloves** *Kehoe Auditorium*	Gouyang Zhou *Purdue University, Industrial Engineering*
1:40pm	**Poster Session 2 & Break (Vote for favorite poster and podium presenters)** *Kettering Lab Atrium & Lobby*	2023-24 PRP Awardees and Other Invited Poster Presenters
2:20pm	**Panel Discussion of the Podium Presentation Topics** *Kehoe Auditorium*	Amit Bhattacharya, Tom Huston, Carolyn Smith, Ellen Wells *University of Cincinnati, Purdue University*
3:10pm	**BEST Award Presentations** *Kehoe Auditorium*	Amit Bhattacharya, PhD, CPE, ERC & PRP Program Director *University of Cincinnati, Environmental and Public Health Sciences*
3:15pm	**Closing Remarks and Program Evaluation** *Kehoe Auditorium*	Amit Bhattacharya, PhD, CPE, ERC & PRP Program Director *University of Cincinnati, Environmental and Public Health Sciences*

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2023-24 PRP Awardee Posters & Invited Posters

#	Title	Presenter	Program
1	**Mental Health and Suicide Among Veterinarians**	Afton Erbe	*University of Cincinnati, College of Nursing*
2	**Assessing the Applicability of Methods to Analyze Metals in Toenails**	Chang Geun Lee	*Purdue University, School of Health Sciences*
3	**Injury Trends for Adolescents with Early Childhood Manganese Exposure**	Danielle McBride	*University of Kentucky, Epidemiology and Environmental Health*
4	**Developing Electromagnetic Shielding Textiles for Personal Protection**	Prakash Giri	*University of Cincinnati, Mechanical and Materials Engineering*
5	**Cool Coat: An Advanced Wearable Thermal Management Solution for Harsh Environment**	Qichen Fang	*University of Cincinnati, Chemical Engineering*
6	**Personal Air Sampling Incorporating Human Factor Ergonomics of Posture and Intensity**	Ryan Bellacov	*University of Cincinnati, Industrial Hygiene*
7	**Impact of Workplace Design on the Health of Breastfeeding Women in Low-wage Jobs**	Amanda Joost on behalf of Stephanie Villella	*University of Toledo, School of Population Health*
8	**Assessing the Impact of Respirator Design and Demographics on the Performance of N95 Respirators**	Xinyi Niu	*University of Cincinnati, Environmental and Public Health Sciences*

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Important Links

Whova app instructions

- App includes speaker bios, agenda, abstracts, locations/maps, and all other event information
- If you registered ahead of time, use the email you registered with to access the event in the Whova app
- If you did not register in advance you can download the app in your app store and use the code **"2ql2xlslke"** to access the event
- Access the desktop version of the event **here**

Voting for favorite poster and presenter
Program Evaluation
Speaker webpage
PRP Agenda webpage
ERC upcoming events

Continuing Education

Attendees are eligible for the continuing education options below, certificates will be emailed after completing the post-event evaluation.

- Meets BGC criteria for IH/CIH professionals; https://gobgc.org/
- Meets BCSP criteria for professional development conference CSP recertification points; https://www.bcsp.org/recertification/

Social Media

Twitter

- Follow us on Twitter @uc_erc
- Use **#24PRP** in all of your PRP related comments and questions so they will be displayed in the event feed

Facebook

- Follow and like us on Facebook at University of Cincinnati NIOSH Education and Research Center

CERKL

- Subscribe to our CERKL pages at CERKL.com to get email newsletters about ERC program events, alumni news, job opportunities and more
- Subscribe to one or all of the ERC CERKL pages to receive updates via email: UC Education and Research Center, UC Environmental & Industrial Hygiene, UC Occupational Health Nursing, UC Occupational Medical Residency, UC Occupational Safety and Health Engineering

Instagram

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Thank you to the Ohio Association of Occupational Health Nurses
For more information about OAOHN visit their website

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2022-23 PRP Awardee Podium Abstracts

Factors and Strategies Influencing Chemotherapy Safety among Oncology Nurses

Dania Abu-Alhaija (PI), Gordon Gillespie, Elaine Miller
University of Cincinnati, College of Nursing

Purpose: The purpose of this research was to describe the factors that affect chemotherapy exposure among oncology nurses and strategies to foster chemotherapy safety by eliciting the perspectives of nurses and nurse managers. There were two specific aims for this research. Aim 1: describe the factors that influence chemotherapy exposure among oncology nurses and strategies to foster chemotherapy safety from the viewpoints of nurses and nurse managers. Aim 2: assess the psychometric properties of the revised Oncology Nurses Health Behaviors Determinants Scale (HBDS-ON) on a sample of oncology nurses. The HBDS-ON was revised based on findings from nurses' interviews.

Design: This study employed a sequential exploratory mixed method design.

Methods: For Aim 1, semi-structured, individual interviews were conducted with 15 oncology nurses and 5 oncology nurse managers by phone. For Aim 2, one hundred and twenty-three oncology nurse participants completed online surveys to test the reliability and validity of the revised HBDS-ON.

Results: Five main themes emerged from analyzing the transcribed interviews 1) description of chemotherapy exposure incidents, 2) nurse personal health beliefs, 3) cues to adhere to chemotherapy handling guidelines in the workplace, 3) invisible exposure to chemotherapy, and 5) strategies to promote the chemotherapy safety at workplace. Exploratory factor analysis of the revised HBDS-ON revealed seven-factor structure with good conceptual meaning. These factors represented the instrument subscales. Convergence validity and regression model testing provided further evidence of the instrument validity. Internal consistency testing supported the subscales' reliability.

Conclusion: Oncology nurses' health beliefs and work-place related factors affect nurses' chemotherapy safety. These factors should be taken into account when developing interventions to promote oncology nurses' occupational health and safety. The Revised HBDS-ON is an instrument that showed evidence of reliability and validity and can be used to measure these factors.

Impact Statement: By identifying the factors that influence oncology nurses' chemotherapy exposure and strategies to promote chemotherapy safety, interventions can be developed and implemented to foster chemotherapy safety among oncology nurses. In the long run, this would decrease the prevalence of chemotherapy exposure among oncology nurses and enhance oncology nurses' safety against this threatening occupational risk.

Carbon Nanotube-based Thermoelectric Fabrics Providing Thermal Comfort and Power Generation for Firefighters

Je-Hyeong Bahk (PI), Vesselin Shanov
University of Cincinnati, Mechanical and Materials Engineering

Purpose: The purpose of this research is to develop thermoelectric (TE) fabrics that can be embedded in firefighter jackets for both personal cooling and power generation.

Design: We use carbon nanotube (CNT) fibers as the active thermoelectric medium, and they are woven with conventional acrylic or nylon fibers together into fabrics. Sections of CNT fibers are selectively doped into n-type and p-

type to make the so-called Π-geometry. The entire fabric is then coated with epoxy resin for electrical insulation to make the final fabric.

Methods: CNT fibers are spun from chemical vapor deposition-grown CNT arrays using the dry spinning method. During the spinning, CNT fibers are twisted to make twisted threads and achieve the desired fiber diameter and mechanical strength. Selected periodic sections of the CNT fiber are dipped into dopant solutions to form doped sections of each p- and n-type. The samples are then tested with varying electric current input to investigate the cooling performance, and with controlled temperature gradients to investigate the power generation performance.

Results: We successfully developed a few fabric samples and tested them for a proof-of-concept study. Our results show that the proposed CNT fabric can be used for effective cooling in firefighter jackets, and for wearable power generation when a large temperature difference is applied between the outside and inside of the jacket.

Conclusion: This work demonstrated the cooling and power generation performance of CNT-based TE fabrics as a proof-of-concept study. Further improvement of material properties and optimization of fabric design will be necessary for future practical application.

Impact Statement: The proposed TE fabric is expected to enhance the thermal comfort of firefighters and thus help significantly reduce the risk of cardiac arrest due to excess heat at a fire scene for them. Even in normal work conditions, the TE cooling fabric will help maintain the temperature inside the suit at the comfort level to reduce mental stresses and physical fatigue. Although it is developed primarily for firefighters, the TE fabric will have broader market opportunities for workers in harsh environment and work conditions including soldiers, construction workers, nurses, and doctors.

Evaluating Microbiome as Biomarkers in Firefighting Associated Stress

Sukanta Bhattacharya (PI), Jagjit Yadav
University of Cincinnati, Environmental and Public Health Sciences

First responders, particularly firefighters, are subjected to various forms of physical stress as well as chemical exposures at the workplace. Epidemiological studies in firefighters have linked these occupational stress factors to various systemic illnesses including but not limited to respiratory and cardiovascular diseases, immune dysfunction, and cancers. Firefighters are subjected to continuous work shifts of multiple days resulting in chronic sleep deprivation (SD). They are also exposed to various chemicals which include the toxicants like perfluorooctanoic acid (PFOA) present in the fire extinguishing foams. Independent human and animal studies have linked SD to an altered immune function, cardiovascular diseases, and hypertension, among others. Immune function is also impacted by the human exposure to PFOA. Studies on animal models have confirmed a suppressed immune system as well as linked different types of cancer to PFOA exposures. Independent epidemiological studies have also linked altered microbiome to various human systemic diseases such as hyperglycemia (blood sugar), hypertension (blood pressure), inflammation, cancer, among others. Continued stress may induce microbiome perturbations which may serve as biomarkers as well as interact with other prevailing environmental stress factors thereby increasing the risk for occupational diseases. This initial study therefore focuses on investigating the impact of co-exposure to SD induced stress and PFOA on the microbiome as a apart of our long-term goal to study the role of occupational chronic stress in inducting microbiome dysbiosis and underlying occupational health conditions in firefighters. We propose to perform these studies using a mouse model of sleep deprivation without or with co-exposure to PFOA. Completion of the study will open up ways to provide insights

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into the role of sleep deprivation and PFOA exposure-induced chronic stress in causing microbiome dysbiosis. These studies will eventually help understand the etiological factors and biomarkers of occupational health risks in firefighters.

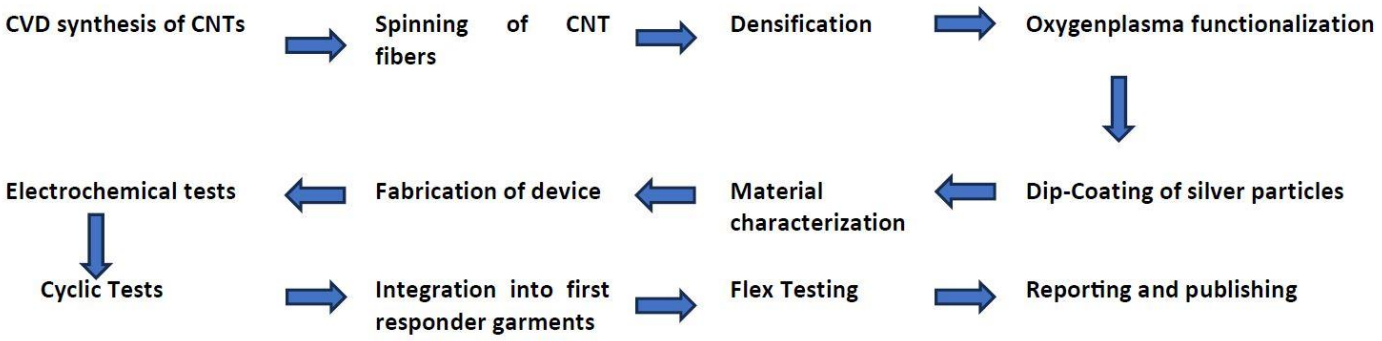
Flexible and Wearable Supercapacitors for Fire Fighters and First Responders

Kavitha Joseph (PI), Vesselin Shanov
University of Cincinnati, Mechanical and Materials Engineering

Purpose: This project aims to design high-performing, flexible, and low-weight wearable supercapacitors based on carbon nanotubes and incorporate them into the garments of firefighters and first responders. The broader impact of this research is the fabrication of wearable and lightweight displays, antennae, sensors, transistors, and energy storage devices for space applications.

Design: The design of the supercapacitor is simple, wherein the silver-coated CNT fiber is sandwiched between the gel-polymer electrolyte. Two types of gel polymer electrolytes are tried, and the differences in electrochemical properties are assessed. The provision for scaling up is also tried by connecting the supercapacitors in series and parallel according to the voltage and current requirements of the applications.

Methods:



Results: The tensile strength of pristine CNT fiber was improved by 40%, which was used to fabricate the supercapacitor device. The supercapacitor device with high energy density and capacitance was fabricated. Aqueous and ionic electrolytes were used and compared. Scalability, cyclic stability, and flexibility aspects are also assessed.

Conclusion: CNT-based high-performing wearable supercapacitors were successfully fabricated. The flexibility of designed CNT-based energy storage devices makes them suitable for a variety of applications. In addition, they can be connected in series and parallel as per the application requirement rendering them scalability advantage for future applications.

Impact Statement: The project will be an asset to the current research on wearable energy storage devices and will pave the way for first responders and other workers to work productively with more safety and ease.

Multi-sensor Occupation Specific Energy Expenditure Models for Race Riders

Michaela Keener (PI)[1], Kimberly Tumlin[2], Nicholas Heebner[3]
[1]University of Kentucky, Rehabilitation and Health Sciences; [2]University of Kentucky, Department of Epidemiology, College of Public Health; [3]University of Kentucky, Sports Medicine Research Institute

University of Cincinnati Education and Research Center (ERC) Supported by the National Institute for Occupational Safety and Health (NIOSH) Grant # T42-OH008432

Purpose: To 1) develop a multi-sensor system to predict reliable energy expenditure through kinetic (e.g., heart rate, oxygen consumption, and respiration rate) and kinematic (i.e., 3D acceleration) of race riders and kinematic data of the horse while exercising live horses; and 2) advance a multi-sensor system from existing pilot data on a galloping simulator to predict energy expenditure through kinetics and kinematics data of race riders while training on a mechanical galloping simulator.

Design: Observational repeated measures study with a convenience sample.

Methods: Eight exercise riders (ExR) will be recruited. Each ExR will complete a set of five simulated rides on a galloping simulator. We will then follow each ExR for a work week while they exercise Thoroughbreds (I.e., riding a horse for fitness of the horse). During this time, we will record the kinematic and kinetic data of the ExR, and the kinematic data of the horse. We will also collect daily workouts, distance and speed traveled, weather, and horse temperament (i.e., behavior) rated by the ExR. Throughout the ExR's work week, we will collect this data on four different days while they exercise the same five horses.

Results: The devices used for data collection are being validated. Primary data collection is targeted for November-December 2023.

Conclusion: The horse racing industry is fast-paced, with change being the norm. Although the racing industry welcomes researchers, horse and rider safety are at the forefront of horse trainers' decisions. Working in this industry requires patience and understanding of community feedback. We are currently in the process of ensuring the equipment we use is validated and reliable but also allows the trainer to feel comfortable that the equipment will not increase risk for the horse or rider.

Impact Statement: The proposed results will inform the racing community and health specialists working with race riders to create healthier training and diet regimens to shift away from current weight-making practices causing mental and physical health decrements. Secondly, this is an excellent example of how community engagement enhances research protocols and the safety of humans and animals.

Evaluating Stress and Wellbeing Trends in U.S. Correctional Nurses

Elizabeth Keller (PI)[1], Beverly Hittle[1], Gordon Gillespie[1], Samantha Boch[1], Kermit Davis[2], Joshua Lambert[1]
[1]University of Cincinnati, College of Nursing; University of Cincinnati, [2]Department of Environmental and Public Health Sciences

Background: Correctional nurses in the United States (U.S.) are known to work in inherently stressful environments due to the punitive nature of correctional facilities paired with staffing shortages, low resources, overcrowding, violence, and deteriorating living conditions of incarcerated persons.

Purpose: To evaluate the impact that work has on the overall wellbeing of correctional nurses, with two aims: (1) quantify organizational characteristics, job stress and wellbeing levels, and (2) determine the relationship of organizational characteristics and wellbeing among correctional nurses in the U.S. with a mediating effect of job stress.

Design: Cross-sectional, non-experimental, descriptive.

Methods: This project employed use of an online REDCap survey and conveniently sampled 270 U.S. correctional nurses to describe organizational characteristics, job stress, and wellbeing levels. Using guidance from the Job Demands-

Resource Theory, this project determined the direct and indirect associations between correctional organizational characteristics (i.e., job demands, job control, managerial support, colleague support, workplace relationships) on nurses' self-reported wellbeing through multiple linear regression modeling and structural equation modeling.

Findings: Results included evidence for moderate job stress (M = 16.26, SD = 7.14) and wellbeing levels (M = 1.8, SD = 3.06), where a score of 2 indicates an increased risk for distress and adverse events. On the continuum from 1 (poor) to 5 (optimal), participant organizational characteristic scores included managerial support (M = 3.13, SD = 0.35), job demands (M = 3.56, SD = 0.922), job control (M = 3.57, SD = 0.77), peer support (M = 3.85, SD = 0.64), and workplace relationships (M = 3.73, SD = 0.95). Registered nurses and those who worked in U.S. prisons had the highest job stress and worst wellbeing levels in this sample. Results also revealed a significant model fit, highlighting the significant impact of job demands, job control, workplace relationships, and job stress on wellbeing. There was also evidence of job stress mediating the effect of job control and job demands on wellbeing.

Conclusion: Results uncover the prevalence of moderate job stress and varying wellbeing levels across different groups of correctional nurses. The updated conceptual model provides guidance for future interventions to target job demands, job control, workplace relationships, and job stress to improve wellbeing for correctional nurses.

Impact Statement: Correctional facilities may leverage these findings and increase job control of nurses by implementing mentorship programs, reduce job demands by ensuring adequate staff are hired and retained, foster positive workplace relationships between colleagues through peer support groups, and mitigate job stress by implementing wellness initiatives. Improving correctional nurse wellbeing may have positive impacts for both the nurses and the organizations, by reducing costs associated with outcomes of poor wellbeing and job stress (i.e., costs for sick days and injuries, retraining new staff due to high turnover).

Nitrogen-doped Three-dimensional Graphene as Sensor for Heavy Metals

Mahnoosh Khosravifar (PI), Vesselin Shanov
University of Cincinnati, Mechanical and Materials Engineering

Purpose: this project proposes to explore the heavy metals sensing application of 3D graphene and its related structures. Due to their large surface area, excellent electrical conductivity, and unique transport properties, graphene materials are great candidates for sensing applications.

Methods: This will be achieved by in-situ doping of nitrogen into the 3D graphene structure using Chemical Vapor Deposition (CVD) method. The detection of heavy metals, including Pd2+ and Cd2+ will be carried out by Square-Wave Anodic Stripping Voltammetry (SWASV) method.

Results & Conclusions: to be completed.

Impact Statement: the broader impact of this research is that this material's structure can be used for biosensing applications, including body fluid analysis, etc.

Cool Helmet for First Responders Based on Nano Carbon Composite and Thermoelectrics

Vamsi Kondapalli (PI), Kyle Brittingham, Vesselin Shanov
University of Cincinnati, Mechanical and Materials Engineering

University of Cincinnati Education and Research Center (ERC) Supported by the National Institute for Occupational Safety and Health (NIOSH) Grant # T42-OH008432

Firefighters while wearing personal protective equipment (PPE) are often exposed to high temperature and physical strain during training and real scenario duty. Hyperthermia is a medical condition due to an abnormal rise in body temperatures above 40oC and can lead to heatstroke thus becoming fatal. Cooling products, like cold packs, are commercially available, however, they only cool the user for several minutes and are made for one-time use. This project focuses on making a prototype helmet with highly efficient thermoelectric (TE) cooling to reduce the head`s temperature of individuals such as construction workers, firefighters, miners, etc. The cool helmet employs a heat spreader for transporting the metabolic and external heat to the TE cooler. A wide variety of heat spreaders like copper foil, commercial carbon veil (CV), CV-cloth composites and graphene composites with 3.5 times the thermal conductivity of copper have been tested taking their cost, mechanical stability, availability, weight, and environmental impact into consideration. The cool helmet was evaluated by heating from the top and the bottom using an incandescent bulb. The temperature was measured and mapped within the 3D space of the helmet by multiple thermocouples and an infrared camera FLIR T1010. The heating and cooling temperature data revealed that the addition of CV and copper foil greatly enhanced the cooling rate compared to the materials normally used in conventional helmets. Further, with the tested heat spreader and TE cooler turned on, the heating time to critical temperature of 40oC was increased by more than 3 times, which confirmed the functionality of the cooled helmet.

Real-time Lifting Risk Prediction Using Tactile Gloves

Guoyang Zhou (PI), Denny Yu
Purdue University, School of Industrial Engineering

Overexertion in lifting tasks is one of the leading causes of occupational injuries. Lifting loads are the key information practitioners require to evaluate the risks of lifting tasks. However, this is challenging because weight varies across different objects and is unknown in many circumstances. Existing methods of predicting lifting loads focused on analyzing body kinematics or muscles' electrical activities, which are indirect indicators of weight and require intrusive wearable sensors. This study proposed utilizing tactile gloves embedded with multiple pressure sensors as a new modality to predict lifting loads. Hand pressure data measured by tactile gloves during each lift was formulated as a two-dimensional matrix containing spatial and temporal information. Different types of deep neural networks were adopted, and a transferred ResNet 18 regression model achieved the best performance. Specifically, it achieved a predicted R-squared of 0.821 and a mean absolute error of 1.579 kg. In addition, to understand the model's decision-making logic and the hand force pattern during lifting, the Shapley Additive Explanations (SHAP) technique was utilized to determine the importance of each sensor at each frame. The results demonstrated that the right hand was more important than the left hand for the model to predict lifting loads. Similarly, fingers were more important than palms, and the middle phase of a lifting task was more important than its beginning and ending phases. Overall, this study demonstrated the feasibility of using tactile gloves to predict lifting loads and provided new scientific insights on hand force exertion during lifting.

2022-23 PRP Awardee Poster Abstracts

Mental Health and Suicide Among Veterinarians

Afton Erbe (PI), Gordon Gillespie
University of Cincinnati, College of Nursing

Veterinarians are at increased risk of experiencing mental health concerns such as depression and anxiety, in addition to suicidal ideation. Evidence shows that veterinarians are more likely to attempt suicide in comparison to the general public. The purpose of this study is to explore mental health and suicide among veterinarians. Specific Aim 1 seeks to

determine the prevalence of burnout, substance abuse, anxiety, depression, and suicidal ideation when looking at medical sub-specialty and career stage (establishment, maintenance, decline). As defined in Super & Jordaan's career development theory, career establishment is between the ages of 25-44 and is when an individual seeks to establish a permanent place and stabilize within their field. Maintenance stage is between the ages of 45-64 with the goal of sustain their place. Lastly, decline occurs at age 65 and up, and is when work duties shift and retirement occurs. This study hypothesizes that individuals who work in emergency medicine and shelter medicine will experience higher rates of mental health issues and suicidal ideation in comparison to other sub-specialties (small animal general practice, large animal general practice, mixed animal general practice, equine medicine, industry, academia). A second hypothesis is that veterinarians in the establishment phase of their career will experience increased rates of anxiety, whereas those in the maintenance career stage will experience increased rates of depression and substance abuse, and those in the decline career stage will experience increased rates of burnout. The knowledge obtained from this study has longitudinal impact and can be used as a basis for assessing the prevalence of mental health issues among this population. It can also be used to develop a future intervention that can be tailored to veterinarians in difference medical sub-specialties and career stages in order to reduce overall rates of burnout, anxiety, depression, and suicide.

Assessing the Applicability of Methods to Analyze Metals in Toenails

Chang Geun Lee (PI), Aaron Specht, Ulrike Dydak, Jae Hong Park
Purdue University, School of Health Sciences

Welders are routinely exposed to welding fumes that contain hazardous metals, such as Mn. Chronic overexposure to Mn has been associated with mood changes, cognition deficits to motor dysfunction, and the progression of Parkinsonism. Biomarkers for chronic exposure and their measurement are critical to identifying the deleterious impacts of the exposures. To estimate chronic exposure to metals, metal concentrations in toenails have been demonstrated to be promising biomarkers. The most frequently used method for the determination of metal levels in toenails is inductively coupled plasma (ICP)-mass spectrometry (-MS) although several other methods such as ICP-optical emission spectrometry (-OES) and X-ray fluorescence (XRF) are also available. So far, no studies have been conducted to provide the appropriate methods for toenail metal analysis in various exposure conditions. The proposed study will address this gap in our present knowledge. The overall objective is to assess the applicability of ICP-OES, portable and benchtop XRFs, for analyzing metals in toenails in comparison with ICP-MS. The central hypothesis is that ICP-OES and XRF can measure toenail metal concentrations as accurately as ICP-MS. To test the hypothesis, we will measure metal concentrations in toenails provided by welders and non-welders in our current existing cohort using ICP-OES (Specific Aim 1) and XRF (Specific Aim 2) and compare the results to ICP-MS measurement. At the end of the project, we will provide results determining the utility of ICP-OES and XRF methods for analyzing metal concentrations in toenail clippings. We will also provide the comparison table of methods including their advantages and disadvantages, which can guide method selection for toenail metal analysis based on the workplace and exposures. The results can be used to improve occupational safety and health in welders and other populations with chronic exposure to metals. Findings from the proposed research will allow us to identify the most appropriate method for future studies. We will use the methods developed and results obtained in this pilot study to prepare the proposal for a larger grant, NIOSH R21 or R01. Our further research can include the development of evidence-based policies and regulations for protecting workers and the general population. Therefore, these studies can be also supported by NIH, NIEHS, and EPA.

Injury Trends for Adolescents with Early Childhood Manganese Exposure

Danielle McBride (PI)[1], Erin Haynes[1], Laurel Kincl[2]

[1]University of Kentucky, Epidemiology and Environmental Health; [2]Oregon State University, Environmental and Occupational Health

The objective of this pilot research study is to investigate adolescents with a known childhood Mn body burden from the CARES cohort to determine if they are at an increased risk of injury in adolescence. We hypothesize elevated concentrations of biomarkers of childhood Mn exposure will be associated with common events leading to injury and being injured in adolescence. This hypothesis will be tested by the following specific aims:

Specific aim 1: Report back CARES adolescent balance study visit findings to Marietta community

Specific aim 2: Characterize injury and work histories of the CARES adolescent participants

Specific aim 3: Determine the association between childhood (age 7-9 years) and adolescent (age 13-18 years) biomarkers of Mn exposure, as measured in blood, hair and toenails and self-reported adolescent injury data.

Developing Electromagnetic Shielding Textiles for Personal Protection

Prakash Giri (PI), Mark Schulz
University of Cincinnati, Mechanical and Materials Engineering

Healthcare workers using electronic and radiative equipments get long term exposure to Electromagnetic Fields (EMFs), which might cause potential physical and mental health risks. Besides, there are concerns about the effect of EMFs on individuals with medical implants such as cardiac pacemakers, insulin pumps and hearing aids, and also on children and pregnant women. Moreover, the use of new type of weapon such as High Energy Microwaves (HEM) is another threat that targets electronics and humans through back door entry. CNT fabric could be a lightweight answer to protecting against EMP and HEM threats. This project targets on utilizing the multi-functional properties of CNT membranes such as low density, customizable porosity and conductivity to develop EMF and HEM shielding textile. The use of suitable dopant will be made using the patented particle injection technology at Nanoworld Laboratories, to tailor the shielding capabilities. The functionalized CNT membranes will also be integrated with different materials such as Kevlar and Polybenzimidazole (PBI) to increase the handleability, strength and temperature resistance. Therefore, this research will target in developing a strong, lightweight and shielding textile that can improve occupational safety to healthcare workers, first responders, soldiers, police force, industrial workers, people with medical implants, and people working in radiative environments such as radio towers. This textile might be helpful in minimizing various physical and mental problems arising due to long term exposure to radiations, along with protection to sensitive equipments.

Cool Coat: An Advanced Wearable Thermal Management Solution for Harsh Environment

Qichen Fang (PI), Vesselin Shanov
University of Cincinnati, Chemical Engineering

This proposal aims to develop the Cool Coat, an advanced wearable thermal management solution designed to enhance personal comfort and safety in harsh environments. The innovative Cool Coat incorporates carbon veil fabric, a lightweight, flexible, and low-cost material known for its high thermal conductivity, along with thermoelectric cooling devices and fans for efficient temperature regulation. The specific objectives of this project include designing and fabricating a Cool Coat prototype, conducting a comparative performance assessment against a control coat without carbon veil fabric, and evaluating the effectiveness of the Cool Coat in distributing cooling. Through the development of the Cool Coat, this project seeks to provide an affordable, user-friendly, and efficient personal thermal management solution with potential applications across various industries, ultimately improving occupational safety and health for

workers exposed to extreme temperatures. By addressing the challenges faced by workers in harsh environments, this project paves the way for innovative temperature-regulated garments to transform the field of wearable thermal management.

Personal Air Sampling Incorporating Human Factor Ergonomics of Posture and Intensity

Ryan Bellacov (PI), Kermit Davis
University of Cincinnati, Industrial Hygiene

This research will determine respiratory dose data for home health workers in a simulated residential work environment. Home healthcare workers continue to be an underrepresented and often underpaid but with an incredible number of workplace exposures. These healthcare workers face risks, including overexertion, shift work, aerosols, and bioaerosols. Unfortunately, air quality within the homes is one more risk factor often overlooked. The types and quantities of pollutant and its sources, and many environmental factors, its worker respiratory absorb dose can vary by a factor of 10 or more. Typically, activity patterns determine when and how long one is exposed to indoor and outdoor pollutants. Therefore, human movements are part of the big picture in reviewing the factors influencing air pollution exposure.

There is a need for a special-purpose activity-pattern study specifically tailored to the problem of estimating air pollution exposures with environmental factors. The most significant factor to workers is underestimating the actual respiratory dose. The proposed study will measure the volumetric intake and respiration rates to better understand the actual exposures when breathing in harmful aerosols and bioaerosols in the home. These dependent variables will be evaluated in response to different body postures, and physical intensities.

Impact of Workplace Design on the Health of Breastfeeding Women in Low-wage Jobs

Stephanie Villella (PI)[1], Amanda Joost[1], Victoria Steiner[1], Tiffani Rose-Wilhelm[2]
[1]University of Toledo, School of Population Health; [2]Therapist and Owner, Tiffani Rose-Wilhelm, LISW, LLC

There is an increasing number of young women working in low-wage jobs every year in the United States (U.S.) labor force, with the largest employment in the food industry. Low-income young women return to work earlier and perform jobs that often make it challenging for them to continue breastfeeding and achieve the health benefits for the child and mother. Mothers of breastfed infants are less likely to experience ovarian or breast cancer later in life, are less likely to suffer from postpartum depression, and have decreased healthcare costs and lower levels of workplace absenteeism. Most research related to breastfeeding in the workplace focuses on full-time, high wage breastfeeding working women and has overlooked the more than 700,000 young low-wage working women. The purpose of this descriptive phenomenological study will be to improve the scientific understanding of the lived experience of women who have recently given birth and have chosen to express breastmilk at low-wage food industry jobs. Specifically, this study aims to: 1) Identify psychosocial hazards, particularly social factors, perceived by breastfeeding mother in low-wage jobs in the food industry; 2) Examine work-related design that sustains a working mother's decision to breastfeed at these jobs; and 3) Determine ways to improve the health and well-being of working mothers who are overrepresented in low-wage jobs. Purposive sampling will be used to recruit 20 mothers to complete a one-time, semi-structured interview and subsequent Photovoice activity. Photovoice is a visual research methodology that puts cameras into the participants' hands to help them to document, reflect upon, and communicate issues of concern. Findings from thematic analysis will contribute to the development of strategies that can decrease occupational stress to reduce complaints, turnover, and absenteeism in women who choose to express breastmilk upon returning to work. Future NIH funding can be used to

advance systems, policies, and practices that will create a healthy work design, and improve well-being by decreasing occupational stress for breastfeeding mothers working in low-wage food industry jobs.

Assessing the Impact of Respirator Design and Demographics on the Performance of N95 Respirators

Xinyi Niu (PI), Jun Wang
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N95 Facepiece Filtering Respirators (FFRs) approved by the National Institute for Occupational Safety and Health (NIOSH) are often used in the occupational environments to provide the wearers with respiratory protection against inhalation of hazardous airborne particles. There are some specific design elements on the N95 FFRs, including nose-clip/shaped designs, respirator shape styles, etc., to avoid the gap between respirator and facial skin, thereby ensuring that respirators provide effective protection for wearers. The first aim of this study will seek to investigate the effect of N95 FFR design (nose-shaped design and respirator style/type) on FFR performance (the degree of protection offered by FFR).

Additionally, individuals of different sex/gender and race/ethnicity may affect the testing results due to the variabilities in facial dimensions. Another aim will to understand how the subject characteristics, i.e., sex/gender and race/ethnicity impact the respirator fit.

Both manikin-based and human subject-based evaluation approaches will be deployed to measure the particle concentrations outside and inside the respirator by the PortaCount. The sodium chloride (NaCl) will be served as the challenge aerosol. A static manikin headform will connect to Breathing Recording and Simulation System (BRSS) to simulate a sinusoidal breathing pattern of a human; while 20 human subjects will be recruited to perform the Occupational Safety and Health Administration (OSHA)-approved quantitative fit testing (QNFT). The protection factor (PF) and fit factor (FF) will be sampled from both approaches. Three cup-shaped N95 FFRs with different nose-shaped design as well as six N95 FFRs with different shape styles will be tested to evaluate the impact of nose-shaped style and respirator shape styles on the respirator performance. The respirator FF-values obtained from the QNFT will be analyzed to investigate the effect of demographics on the performance of N95 FFRs.

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