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OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)

A. COVER PAGE: OVERALL

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
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Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The University of Michigan Center for Occupational Health and Safety Engineering (UM COHSE), a NIOSH Education and Research Center (ERC), has the mission of serving the region, nation, and world as a center of excellence for research and graduate education in Occupational Health and Safety (OHS). Our constituencies include NIOSH; industry, labor, government, and professional interests in our region; academic units within the University of Michigan that provide critical teaching and research resources (including tenured faculty positions) necessary for Center success; and our students, including both full time students enrolled in our graduate degree programs as well as those engaged in our continuing education programs.

The goals of the Michigan ERC are to:

- Promote excellence in professional training and research training programs in each core program;
- Increase the resources needed to improve the number, quality, and diversity of students in each core;
- Enhance the quality of our CE courses and other service and outreach activities;
- Increase external research funding, improve our research infrastructure, expand opportunities for research training, and promote interdisciplinary research related to occupational health and safety;
- Provide an organizational structure and significant opportunities to coordinate, promote and synergize interdisciplinary education and research activities for core programs;
- Increase awareness and education of OHS in undergraduate and graduate courses in other departments and schools, and among the public at large;
- Use research-to-practice mechanisms and partnerships to move research results into the workplace;
- Assist Center programs and affiliated academic units in recruiting, promoting, and retaining faculty; and
- Ultimately, to make significant impact in improving health, safety, and wellbeing in the workplace.

B.2. What did you accomplish under these goals?

Highlights of the reporting period (2018- 2023) include: new faculty hires and promotions in all programs; numerous scholarly publications by faculty and students; development of new courses; and increased regional collaborations. During this period, 160 NIOSH-supported graduate students were enrolled (118 Master's and 42 doctoral), and 86 Master's and 24 doctoral degrees were awarded. Our CE portfolio over the period included more than 150 programs attended by 20,000 people, resulting in more than 120,000 contact hours of training across many occupational health and safety (OHS) areas.

Leadership.

The Michigan ERC has had several notable, planned changes in leadership and administrative staff over the reporting period. *Changes have been orderly and the transitions have been smooth*. In 2022, the *Center Directorship* passed from Prof. Stuart Batterman, who served in that role from 2010-2022, to Prof. Rick Neitzel. Prof. Batterman is Professor of Environmental Health Sciences (EHS) in the School of Public Health (SPH) and Professor of Civil and Environmental Engineering in the College of Engineering (COE), and Prof. Neitzel is Professor of EHS in SPH. The *Center Deputy Directorship* was held by Prof. Marie O'Neill, Professor of EHS and Professor of Epidemiology in SPH, from 2018-2020, Prof. Neitzel from 2020-2022, and Prof. Batterman starting in 2022. In 2020, the *IH program Directorship* transitioned from Prof. Ted Zellers, who served in that role from 1999 until his retirement in 2020, to Prof. Neitzel. In 2023, the *OHN program Directorship* will transition from Prof. Marjorie McCullagh, Professor of Nursing in the School of Nursing (SON) who served in that position from 2009 until her retirement in 2023, to Prof. Marie-Anne Rosemberg, Assistant Professor of Nursing in SON. Prof. Nadine Sarter, Professor of Industrial and Operations Engineering in COE, served as *OSE program Director* from 2018-2020, at which time Assoc. Prof. Leia

Stirling, Professor of Industrial and Operations Engineering in COE, became Director and Prof. Sarter became Associate Director.

These transitions have stemmed largely from retirements and hiring of new faculty members. However, the ERC has preserved continuity in every program though continuing leadership and input from past directors and senior faculty while improving the balance of junior and senior faculty and at the same time introducing enthusiastic new faculty. Even with the transitions, *the current directors have a combined experience with the ERC of 55 years.* In addition, support staff have many years of experience with the Center, and deserve mention and acknowledgement given their essential role in Center activities.

New Center-wide initiatives**.** The Center Directors and Executive Committee (which includes all Program Directors) have undertaken major steps to increase the ERC's effectiveness and impact. These include:

- Partnering with the UM *Center for Research on Learning and Teaching (CRLT)* to provide high quality and professional evaluation services using a utilization-focused approach that rigorously captures the quality, impact, effectiveness and need for Center activities and programs.
- Continuing to strengthen the *Regional ERC Consortium* between ERCs at UM, the University of Illinois-Chicago and the University of Cincinnati to promote collaborations, interactions and synergies. This activity has resulted in a series of annual *Joint Research Symposia on Occupational Health and Safety*.
- Expanding our *External Advisory Board* (EAB) to increase diversity and program representation, to better reflect our stakeholders, and to increase EAB engagement.
- Embracing *Diversity, Equity and Inclusion* (DEI) in all aspects and levels of Center operations, including student and faculty recruitment and selection, EAB member recruitment, educational program content, outreach endeavors, and governance.
- Increasing interactions with *outside organizations*, e.g., *Workplace Health Without Borders -- US Chapter* that focuses on underserved workers and employers internationally, and the *Michigan Occupational and Environmental Medical Association* that provides medical students with occupational medicine (OM) internships.

While the COVID-19 pandemic had undesirable but unavoidable **impacts on educational programs from early 2020 forward,** the Center successfully pivoted and continued to administer high-quality education and experiences to our trainees.

Faculty

The productivity and quality of the Michigan ERC faculty and programs in the current reporting period have been recognized by promotions, recruitment of new faculty, an exceptional level of scholarship and research – e.g., more than 900 research publications – during the project period, an outstanding breadth and depth of their outreach, CE and service activities, and many distinctions. These qualities and activities emphasize two critical strengths of the Michigan ERC: (1) a *very high level of research, teaching and service accomplishments* by our faculty; and (2) the *long-term commitments to ERC core programs* by the faculty and supporting institutions in COE, SPH, and SON. Tenure commitments assure the stability of all ERC academic and research programs. Overall, our faculty are remarkably productive, stable and committed to the ERC.

Promotion and new faculty hires occurred in each of the Center's four academic programs, as shown below in Table 1.

Table 1. Promotions and new faculty hires.

Name	Promotion or Hire	Year	Affiliation ERC/Unit
Rick Neitzel, PhD, CIH	Professor with tenure	2021	EPC / IH / SPH-EHS
Leia Stirling, PhD	Associate Professor with tenure (hire)	2019	OSE / COE
Kelly Bakulski, PhD	Assistant Professor (hire)	2019	OEE / SPH-EPID
Aurora Le, PhD, CSP	Assistant Professor (hire)	2020	IH / SPH-EHS
Miatta Buxton, PhD	Assistant Research Scientist (hire)	2019	OEE / SPH-EPID
Simone Charles, PhD	Clinical Assistant Professor (hire)	2018	OEE / SPH-EHS
Kevin Joiner, PhD	Assistant Professor (hire)	2019	OHN / SON
Elizabeth Kuzma, DNP	Clinical Associate Professor	2022	OHN / SON

Faculty research productivity and dissemination. Our faculty and students were very active in research dissemination. OSE core faculty and students prepared and/or published 225 research papers and reports, with students as primary authors or co-authors on 110 of these. OHN core faculty and students published 54 research papers and report and made 42 presentations. Students were co-authors on 16 papers and 15 posters. The core IH faculty prepared 202 publications and 39 presentations; 101 and 24 of these, respectively, had student co-authors. OEE core faculty and students published 473 papers.

Faculty accomplishments and recognitions.

Several are highlighted below by program.

- OSE faculty received *ten significant academic and professional society recognitions* of excellence, e.g., OSE Director Stirling was named an *American Institute of Aeronautics and Astronautics Associate Fellow,* and Associate Director Sarter was elected to the *National Academy of Engineering.*
- OEE Director O'Neill was named the *SPH Faculty Lead for DEI* in 2020; Profs. Park, Adar, and Bakulski were each awarded R01 grants from NIEHS; Prof. Robins received a *Fogarty GEOHEALTH Grant for International Health* to develop OSH capacity in southern Africa; and Prof. Meeker is PI on several major NIEHS grants.
- OHN faculty received over eight significant distinctions, e.g., Director McCullagh received the *APHA Public Health Nursing Section Ruth Freeman Award* and was designated by the American Academy of Nursing as an *Edge Runner*. Associate Director Rosemberg was appointed to the *NIOSH Service Sector Council* and became Associate Editor of Current Topics for *Workplace Health & Safety.* Prof. Friese was appointed by President Biden to the National Cancer Advisory Board.
- IH faculty accomplishments included hiring of Prof. Le and promotion of Director Neitzel. Prof. Neitzel was elected Chair of the *ACGIH TLV Committee on Physical Agents,* received the NHCA *Threadgill Award for Outstanding Leadership*, and became PI of the nationwide *Apple Hearing Study*; Prof. Meeker leads projects in 2 large, multi-investigator Center-type grants (*Superfund Research Program, ECHO*), is currently PI for 2 R01 grants from NIH/NIEHS and Co-I on additional R01 grants; and Prof. Zellers obtained major funding from IARPA to develop microscale gas chromatograph technology.

Overall.4.c Academic programs

New and substantially revised courses. We continue to refine and enhance curricula as detailed in the individual program narratives, as shown in Table 2.

Table 2. Examples of new or substantially revised courses in the project period.

- EPID/EHS 608 – *Occupational and Environmental Epidemiology* (Handal). This cross-listed course was substantially revised to increase the coverage of occupational health concepts principles.
- EHS/EPID 675 *Advanced Data Analysis in Epidemiology* (Park). This cross-listed course was substantially revised to increased coverage of advanced non-parametric methods.
- IOE 837/EHS 688 *Interprofessional Perspectives on Occupational Health and Safety* (taught during the reporting period by Profs. O'Neill, Batterman, and Stirling). This ERC-wide cross-listed course was completely restructured to emphasize competencies in interprofessional education. The revision resulted in a peer-reviewed publication, with ERC Directors and trainees as authors (McCullagh et al, 2022)
- IOE 491 - *Quantifying Human Motion Through Wearable Sensors* (Stirling). This is a new course that introduces the use of inertial measurement units for measuring human motion strategies.
- IOE 534 – *Occupational Biomechanics* (Martin). This new course introduces anatomical and physiological concepts to understand and predict human motor capabilities, with particular emphasis on the evaluation and design of manual activities in various occupations.
- EHS 604 – *Integrated Approaches in Environmental Health* (Charles). This course was revised to integrate academic principles, practical skills, and concepts in EHS related to real-world problems.
- EHS 796.002 - *Healthy and Safe Nail Salon Workers (*Le and Rosemberg). This interdisciplinary course evolved from the Michigan Healthy Nail Salon Cooperative project, and is co-taught by two ERC faculty.
- EHS 796.004 - *Psychosocial Aspects of Occupational Safety and Health* (Le). This new course addressing a range of psychosocial factors that impact workplace health and safety.
- EHS 592 - *Infectious Disease and Emergency Response* (Le). This new course that addresses infectious disease outbreaks and control and the role public health practitioners have in emergency response.
- EHS 658 – *Physical Hazards* (Neitzel). This course was expanded to incorporate ionizing radiation, previously taught in a separate course, EHS 581 – *Radiological Health*.

Curriculum changes. The major curricular revisions over the reporting period occurred in School of Public Health (SPH) programs. Masters of Public Health core coursework in SPH was completely revised, and a new sequence of required core courses launched in 2019. This directly impacted students in the IH and OEE programs. Center Director Neitzel teaches one of the new core courses, PH 514 – *Public Health Sciences in the Environment*, and introduced OHS content into the course. As part of these curricular revisions, new requirements for *Applied Practice Experiences* and *Integrated Learning Experiences* were applied to all MPH students. The capstone EHS course taken by IH and OEE students, EHS 604 - *Integrated Approaches in Environmental Health*, was also completely revamped to integrate academic principles, practical skills, and EHS concepts in the context of real-world problems. With the addition of Prof. Le to the IH faculty in 2020, the IH program also added substantial new coursework. Prof Le's new courses are: EHS 796.002 - *Healthy and Safe Nail Salon Workers* (an interdisciplinary course co-taught by Profs. Le from IH and Rosemberg from OHN); EHS 796.004 – *Psychosocial Aspects of Occupational Safety and Health*, which addresses psychosocial factors that impact OHS, consistent with NIOSH's Total Worker Health framework; and EHS 592 – *Infectious Disease and Emergency Response*, which addresses infectious disease outbreaks and control. Additionally, EHS 658 – *Physical Hazards,* taught by Center Director Neitzel, was expanded to incorporate ionizing radiation. EHS 653 – *Environmental Sampling and Analysis Laboratory* and EHS 654 - *Control of Airborne Contaminants* were also heavily revised to focus more on real-world application of fundamental concepts.

Student enrollment, diversity, graduation, and accomplishments

Enrollments and program graduates. We exceeded our targets for enrollment and graduates of all of our programs (IH, OSE, OHN and OE). Over the reporting period, our academic programs enrolled 180 students and graduated 71 Masters and 23 doctoral students. Enrollment trends are generally stable or positive among our programs. Major and increasing efforts in diversity recruitment are succeeding due to *Diversity, Equity and Inclusions* initiatives at the university level, as well as within the Center. Over the past project period for which data exist, underrepresented minority students accounted for 11% of the U.S. citizens attending OSE, 8% of the OHN students, 8% of the IH

students, and 34% of the OEE students. We are pleased that we have been able to maintain stable or positive trends in enrollments and graduation rates given the significantly increasing educational costs (tuition, fees, etc.), economic and demographic stress in our region, and the general decline in OHS nationally. This performance is attributed to (1) the *quality and reputation* of our programs and faculty, and (2) faculty success in *procuring research funds and clinical training opportunities* to help support students, and (3) *NIOSH support* of the ERC. Performance is summarized below by program over the past four years.

- In OSE, enrollment averaged 6 students per year (range 3-8 students per year), and 5 Masters students and 8 PhD students graduated. Student distinctions included Na Du receiving the *HFE WOMAN Rising Star Award*, *HFES Student Member with Honors Award*, and *HFES Aging Technical Group Scholarship* and Yadrianna Acosta-Sojo being awarded a prestigious *NSF Graduate Fellowship.* Placements of Masters graduates were primarily in the government, while placements of PhD graduates included faculty positions, and university and federal laboratories, and private industry.
- In OHN, enrollment averaged 9 students per year (range 7-12 students per year), and 14 Masters and 7 doctoral students graduated. Student distinctions included Nathan Stefanovsky receiving the *Sigma Theta Tau International Honor Society of Nursing Rho Chapter Evidence-based Practice Award*, and Laura Ridge receiving the *UM African Social Research Initiative Award.* Graduates achieved high rates of Nurse Practitioner certification within one year of graduation.
- In OEE, enrollment averaged 7 students per year (range 6-7), and 21 MPH students and 5 PhD students graduated to assume OH-related positions at county and state health departments, OSHA, and elsewhere.
- In IH, enrollment averaged 18 students per year (range 15 to 22 students per year), and the program graduated 2 PhD and 41 Masters students. Of the total, 39 secured positions in IH or a closely related field. IH students successfully competed for more than 40 external scholarships during the reporting period.

Outreach and Continuing Education

Continuing Education. The Michigan ERC's Outreach and CE Programs are directed by Dr. Sheryl Ulin, who has academic and professional credentials in OHS. Our CE portfolio for the reporting period was dynamic and impactful. It included *on-site courses, synchronous and asynchronous webinars, hybrid (in-person and online) courses,* and online *YouTube* videos. Many of the webinars are also recorded for asynchronous viewing. Overall, we conducted more than 140 continuing education programs, which included 140 live, hybrid, and online course attended by more than 20,000 people, resulting in 104,591 contact hours of training. This surpasses our annual goal of 15 programs. Course offerings addressed IH, OSE and ergonomics, and OHN, and were attended by professionals in these disciplines, occupational medicine, and others.

Several of our offerings are nationally and internationally known and long standing, e.g., we have offered the *Human Factors Engineering Short Courses* for 61 years and the *Warren Cook Health and Safety Discussional* for 59 years. Others are new or were substantially revised, including: co-sponsoring the *Workplace Mental Health Conference*, which directly addresses elements of NIOSH's TWH framework, in 2021 and 2022, as a collaboration with the Michigan Medicine Eisenberg Family Depression Center; a revised two-day *Ergonomics Principles for Workplace Assessment and Design course*; a 2019 workshop on *Risk Assessment for Asbestos and Other Fibrous Minerals*; a *Multi-Professional Oncology Safety and Simulation Training* course from 2018-21; and COHSE has co-sponsored the annual *Michigan Industrial Ventilation Conference* since 2018.

As in past years, we have strong participation by Center faculty as planners, directors and lecturers in our programs. Our faculty are nationally and internationally recognized for their expertise, and obtain high ratings in evaluations. They allow us to identify, attract and utilize complementary national and international experts in our programs that expands our ability to cover a broad range of topics. Our evaluations demonstrate that course attendees consistently identify faculty/speaker quality as a major reason for attending our programs.

Outreach. Outreach activities were extensive and included educational development, consultations, assistance to small businesses and government, development of internet resources, conference participation and co-sponsorship, and service to professional organizations. Examples are given **in Table 3.**

Table 3. Examples of outreach activities in the project period.

- Educational development included hundreds of presentations, lectures and demonstrations by Center faculty on OHS topics at universities, labor organizations, trade and professional associations, government agencies, private employers, schools, and elsewhere. International development included the *NIOSH GeoHEALTH Program in Western Africa* (Profs. Robins, Batterman), as well as international research conducted by individual ERC faculty (e.g., Profs. Neitzel, O'Neill, Handal) in various countries.
- Consultations on OHS topics were provided to many organizations to assist with workplace/work system analysis and design; OHS policies, exposure, impact and risk assessment; research; and legal and management support. As highlights, OHN Prof. Friese was appointed to the National Cancer Advisory Board; Center Deputy Director Batterman serves on several task forces with the State of Michigan; Center Director Neitzel and Prof. Le assisted UM, the state of Michigan and NIOSH (through an Intergovernmental Personnel Agreement) on the COVID-19 pandemic; and Center Director Neitzel advises the World Health Organization on their "Make Listening Safe" initiative.
- Small business assistance, funded by a *Consultation, Education and Training* grant from the State of Michigan, was led by ERC faculty and staff, and included on-site ergonomics training to approximately 200 people annually, which then reached >6,300 people via on-site and virtual seminars.
- Internet resources include maintenance of a 7,700 member listserv, another nursing listserv, a monthly center-wide announcement, our ERC website, and Facebook, Twitter, and LinkedIn accounts.
- A new Massive Online Open Course (MOOC) on environmental health sciences, including a focus on occupational health and safety, by Center Director Neitzel that has already reached >7,000 learners.
- Conference co-sponsorship and exhibitions promote OHS awareness and academic and CE opportunities. We co-sponsored, exhibited, or presented at the *Applied Ergonomics Conference*, the *American Industrial Hygiene Conference and Exposition*, the *Human Factors and Ergonomics Society*, the *Michigan Safety Conference*, the *AAOHN National Conference*, and many others.
- Awareness raising activities included student-developed "Safety Days" and "Wellness" events, bus tours introducing lay persons to OHS concerns in Detroit; on-campus events, e.g., OSE students hosting *ErgOlympics* and *ErgoExpo* to educate the public on ergonomics; regional collaborations with other ERCs; engagement with federal, state and local legislators and communities; and media interviews.
- Professional service is extensive, e.g., Profs. Martin and Neitzel are on the *ACGIH TLV Physical Agents Committee*, and Profs. O'Neill, Rosemberg, Batterman, Meeker, Sarter, and others serve as journal editors and on grant review committees for NIH and other agencies and foundations.

Research

Pilot Project Research Training Program. In the reporting period, we funded 22 PPRT projects out of 42 applications received. These projects provide direct support of doctoral students and early career researchers in NORA priority areas. We funded projects throughout our region (DHHS Region V) in Indiana, Wisconsin, Ohio and Michigan. These have resulted in numerous publications and further grant support.

Doctoral student research scholarships. Direct stipend/tuition support is provided to doctoral students to address NORA priority areas through our TRT Program, which supported 7 trainees during the 2018-2023 period. The program attracted outstanding students who pursued NORA-related research in a very interdisciplinary manner that benefits from ERC's resources and faculty expertise.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

As a T42 Education and Resource Center, the Michigan Center conducts a wide range of training and professional development opportunities in the field of occupational safety and health (OSH). For students in our four degree awarding academic programs, namely, *Industrial Hygiene* (IH), *Occupational Health Nursing* (OHN), *Occupational Safety Engineering and Ergonomics* (OSE), and *Occupational & Environmental Epidemiology* (OEE), we provide didactic coursework, mentoring, directed research, supervised internship placements, seminars, conference participation and sponsorship, on-line training, and many other activities pertaining to training in occupational health and to interprofessional education. These opportunities are summarized in the reports for each of the academic programs. The Michigan Center offers numerous *Continuing Education Programs*, each of which offers opportunities for training and professional development. Participants in these programs advanced their knowledge and skills in OSH-relevant areas. These opportunities and activities are summarized in our *Continuing Education Program* report.
For faculty and staff in the Center themselves, the Center and University of Michigan encourages development of professional skills and experiences to attain greater proficiency. Opportunities include on-line courses, seminars, and workshops offered by the *UM Center for Research on Learning and Teaching* (CRLT) and others, e.g., this spring 2021 one of our junior IH Program faculty, Dr. Aurora Le, will partake in a grants writing program offered by our sister ERC in Cincinnati through our regional ERC consortium.

For participants in our *Pilot Project Research Training Program*, including PhD students, postdoctoral fellows, and junior faculty at colleges and universities in HHS Region V (the Great Lakes Region), we enhance opportunities for research training in OSH topics using short-term seed funds to support innovative pilot research projects in priority areas defined in the National Occupational Research Agenda (NORA), and we promote interdisciplinary and networking activities of these individuals though our Regional OSH Research Symposium.

B.5. How did you disseminate the results to communities of interest?

The Michigan ERC (Center) disseminates results and OHS information through many channels and to many communities of interest. These are summarized below. Further details are provided in the accomplishment sections of the Continuing Education (CE) Report and the Outreach Report.

- For CE, we conducted numerous continuing education programs and webinars, which were attended by thousands of attendees. These CE programs effectively disseminate OHS information to the practicing community.
- For outreach, we provide dissemination through multiple mechanisms to reach multiple audiences. Activities conducted by individual UM faculty and staff disseminate OHS information via seminars, presentations, workshops, panels, committees, and other means and affiliations. The Outreach Report lists numerous activities of our highly active and visible faculty. These address local, national, and international audiences and a wide range of OHS areas.
- Scholarly publications and presentations by our highly productive faculty span a wide reach across OSH field and reach many both scientists and practitioners in the field.
- The Center sponsored tours, seminars, and panels, all intended to introduce safety and health issues, concepts, and solutions to the broader lay community.
- The Center also conducted larger-scale projects with external funding support via the State of Michigan's Consultation, Education and Training (CET) grant, which provided assistance to many small Michigan businesses to address ergonomics issues. A YouTube channel, C4E TV, contains more than 80 ergonomic case studies; this resource is free.
- Finally, the Center conducted many other outreach and dissemination activities, which included webcasts (available on the ERC website); conference exhibits (e.g., at the Applied Human Factors and Ergonomics Conference, International Ergonomics Association, Human Factors and Ergonomics Society, Applied Ergonomics Committee, American Industrial Hygiene Conference and Exposition and the Michigan Safety

Conference); website upgrades; use of Twitter and Facebook; co-sponsorship of conferences, e.g., national ergonomics conference; distribution of flyers (e.g., "Why study occupational health?"); and co-sponsorship of the Midwest ERC Regional collaboration Research And Practice Symposium, to be held March 2020 in Frankfort, KY.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

Broadly, the Center overall and its individual programs will continue to monitor, evaluate, and modify our strategies to assure maximum flexibility and responsiveness to new challenges. Continual refining of our approach should help to assure strong coordination and integration across Center programs, retention and growth of faculty and resources, and excellent use of the advice and guidance of our Executive Committee and our External Advisory Board. While the Covid-19 pandemic has forced increased utilization of distance-based approaches, overall, we do not anticipate major significant changes in objectives and scope of our program. Incremental changes include increased attention to pandemic-related issues, emergency response, diversity and trainee pipeline progression, and other new research and training initiatives.

Specific goals for the next 5 years include:

1. continuing to enhance our curricula to meet evolving training needs;
2. increasing awareness of OHS and enrollment in our programs;
3. continuing to offer high quality CE courses;
4. maintaining research programs at the cutting edge of OHS and using research-to-practice (r2p) mechanisms and partnerships to move research results into the workplace;
5. increasing alumni engagement, and; (6) engaging the broader public community through outreach and service.

C. PRODUCTS

C.1. Publications, conference papers, and presentations

N/A

C.2. Website(s) or other Internet site(s) – include URL(s)

cohse.umich.edu

C.3. Technologies or techniques

C.4. Inventions, patent applications, and/or licenses

C.5. Other products and resource sharing

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
RNEITZEL		Neitzel, Richard L	BS,MS,PHD	**PD/PI** (22-23)	0.0	1.2	0.6			
RNEITZEL		Neitzel, Richard L	BS,MS,PHD	Co-Investigator (18-19, 19-20, 20-21, 21-22)	0.0	1.2	0.6			
STUARTB	Y	BATTERMAN, STUART A	BS,MS,PHD	**PD/PI** (18-19, 19-20, 20-21, 21-22)	0.0	2.1	1.1			
STUARTB	Y	BATTERMAN, STUART A	BS,MS,PHD	Co-Investigator (22-23)	0.0	2.1	1.1			
ADFINKEL	Y	Finkel, Adam M.	BS,MS,Sc.D	Co-Investigator (21-22, 22-23)	1.2	0.0	0.0			
LEIAS1	Y	Stirling, Leia	BS,MS,PHD	Co-Investigator (21-22,22-23)	0.0	0.7	0.5			
MARIEO	Y	O'Neill, Marie Sylvia	PHD,MS,BA	Co-Investigator (18-19, 19-20, 20-21, 21-22, 22-23)	0.0	0.6	0.4			
MARJORIE.MCCULLAGH	Y	MCCULLAGH, MARJORIE E	PHD,MSN,BSN,BS,MS	Co-Investigator (18-19, 19-20, 20-21, 21-22, 22-23)	0.0	1.8	0.3			

SHERYLUL	Y	Ulin, Sheryl Sue	BS,MS,PHD	Co-Investigator (18-19, 19-20, 20-21, 21-22, 22-23)	5.5	0.0	0.0			
EZELLERS	Y	Zellers, Edward T	BA,MS,PHD	Co-Investigator (18-19, 19-20, 20-21)	0.0	0.6	1.0			
SARTER	Y	Sarter, Nadine Barbar	BS,MS,PHD	Co-Investigator (18-19, 19-20, 20-21)	0.0	0.9	0.3			

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The University of Michigan Center for Occupational Health and Safety Engineering (UM COHSE), a NIOSH Education and Research Center (ERC), has the mission of serving the region, nation, and world as a center of excellence for research and graduate education in Occupational Health and Safety (OHS). In conducting the various training and research activities sponsored by the center, the Michigan ERC is enhancing academic and practitioner human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OHS academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards, as well as new OHS practitioners who can directly apply the knowledge and skills obtained from the Michigan ERC program to promote and protect the health of American workers.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The public health relevance of this training grant is that we have trained multiple students in the field of occupational health of safety (including industrial hygiene, occupational and environmental epidemiology, occupational health nursing, and occupational safety engineering), and their research and career trajectories has contributed to the overall goal of improving occupational safety and health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them
The major challenge to the ERC over the project period were restrictions and other actions associated with the COVID-19 pandemic. The COVID-19 pandemic greatly reduced travel and personal interaction with others. During the project period, UM continued restrictions that limited building access, other student and researcher activities, teaching went on-line, and research was encouraged or required to go on-line. In January 2022, UM teaching resumed face-to-face, although many courses remained on-line and some were hybrid. These and other aspects associated with the pandemic had impacts on trainee recruitment, teaching and research, however, the ERC programs pivoted successfully to the virtual format. Some details are provided below.

Academic Programs:
OHN Program. Given the high demands on medical staff, instruction in our OHN Program shifted to entirely hybrid and remote course delivery – important since nearly all program trainees continue to work in primary care as they study. In 2021, the Program restored student clinical placements that were largely halted by affiliating agencies in 2020 due to the pandemic.

IH, OEE, and OSE Programs. Programs shifted to a virtual format and resumed hybrid format in January 2022.

Outreach Program.
Conference exhibits were virtual, and it was difficult to connect with conference attendees since most people did not "visit" our booth. We increased our presence on social media as a method to reach a greater number of people.

Continuing Education Program.
CE courses were turned to virtual programs. The virtual courses were provided in two basic formats:

1. Synchronous presentations while recording the lectures for additional viewing asynchronously. Course attendees are able to ask questions during the presentation.
2. Asynchronous presentations with synchronous discussion sessions. During the discussion sessions course attendees asked questions and the instructors presented supplementary material / case studies to create interaction among the attendees. The discussion sessions were also recorded for asynchronous viewing by course registrants.

Service and engagement related to COVID-19
Faculty, trainees and staff assisted with the pandemic response at University, State and National levels. Some highlights are listed below.

3. IH Program Director R. Neitzel has an appointment through the intergovernmental Personnel Act (IPA) to assist the National Institute of Occupational Safety and Health in its response to COVID-19 among construction workers.
4. Professors Aurora Le in the IH Program also has an appointment through the intergovernmental Personnel Act (IPA) to assist the National Institute of Occupational Safety and Health in its response to COVID-19 pertaining to communications and outreach.

5. Several faculty are conducting surveillance of the SARS-CoV-2 virus in campus environments including in air and wastewater

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

n/a

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
n/a

G.2 Responsible Conduct of Research

All trainees supported by the Michigan ERC were required to complete training in Responsible Conduct of Research and Scholarship. The mechanisms used to deliver this training differed by program; for specific details, please refer to the appropriate program (i.e., Industrial Hygiene, Occupational and Environmental Epidemiology, Occupational Health Nursing, Occupational Safety Engineering, Targeted Research Training, or Pilot Project Research Training program).

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
n/a

G.4.b Inclusion Enrollment Data
n/a

G.4.c ClinicalTrials.gov
n/a

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
n/a

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

n/a

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

n/a

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

n/a

G.8 Project/Performance Sites

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3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
n/a

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

G.11 Program Income

Is program income anticipated during the next budget period?
n/a

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
n/a

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The University of Michigan Center for Occupational Health and Safety Engineering (UM COHSE) conducted a wide range of activities related to professional training, research, outreach, continuing education, and service in the field of occupational safety and health (OSH). We supported trainees and programs in four disciplines, namely, *Industrial Hygiene* (IH), *Occupational Health Nursing* (OHN), *Occupational Safety Engineering and Ergonomics* (OSE), and *Occupational Epidemiology* (OE). The Center supported graduate level professional training culminating in Master of Public Health (MPH), Master of Science (MS), Master of Engineering (MSE), and Master of Nursing (MSN) degrees, and

supported research training culminating in doctoral degrees in these areas. Center faculty taught courses, mentored students and post-docs, directed research, pursued and obtained grant funding, published research articles, administered various aspects of the program, and performed service to the program, department, school, university, local/regional stakeholders, and broader community. In addition, the Center coordinated activities among our core disciplines including several new initiatives, engaged in program evaluation activities, and provided administrative support.

During the reporting period, new faculty were hired and faculty promotions occurred in all four disciplines programs; more than 900 scholarly publications were produced by faculty and students; new courses were developed; and regional collaborations were increased. During this period, 160 NIOSH-supported graduate students were enrolled (118 master's and 42 doctoral), and 86 master's and 24 doctoral degrees were awarded. Our CE portfolio over the period included more than 150 programs attended by 20,000 people, resulting in more than 120,000 contact hours of training across many occupational health and safety (OHS) areas.

A. COVER PAGE- ADMIN PEC

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The overall mission of the Michigan ERC is to serve the region, nation, and world as a center of excellence for research and graduate education in Occupational Health and Safety (OHS). Our major goals are to provide professional training (Masters of Public Health [MPH] and Masters of Science [MS]) and research training (Doctoral [PhD]) in OHS, to conduct cutting edge research, to provide high level and effective continuing education programs, to conduct targeted research training, to provide service to constituencies in our region including industry, labor, government, professional organizations and the public, and to conduct dynamic outreach activities that reach diverse audiences.

The major goals of the Planning and Evaluation Core (PEC) include the following:

- Coordination and integration of the Center programs.
- Assessment of the overall productivity, effectiveness, and need for Center programs.
- Provision of overall organization of Center-wide activities.
- Organization and management of internal and external advisory committees.
- Managing interactions with stakeholders, other ERCs, NIOSH, and other groups and organizations relevant to the Center's mission.
- Management of the Center's website and other communication activities.
- Oversight of the Center-wide interdisciplinary coordination plan.
- Oversight of the Center-wide diversity recruitment plan.
- Promotion of communications and outreach.
- Oversight of NIOSH and other contractual requirements for budgeting, student tracking, and reporting.

These goals did not change during the project period.

B.2. What did you accomplish under these goals?

Major activities

The University of Michigan Center for Occupational Health and Safety Engineering (COHSE) Planning and Evaluation Core (PEC) conducted many activities to attain our objectives, which included planning, implementation and review for program evaluation, strategic planning, program revision, and program promotion. In addition, the PEC helped with updates to training materials, student recruitment, budgeting, reporting to NIOSH, xTRAIN reporting, program evaluation, outreach, and research related activities, including planning for our research symposia. The PEC coordinated these activities and received input through regular and informal contact with faculty and trainees, monthly meetings of Program Directors/Executive Committee, and annual or biannual meetings of our External Advisory Board (EAB).

Specific objectives

The specific objectives of the PEC include the following:

- Coordination and integration of the Center programs.
- Assessment of the overall productivity, effectiveness, and need for Center programs.
- Provision of overall organization of Center-wide activities, reporting and administration.
- Organization and management of internal and external advisory committees.
- Managing interactions with stakeholders, other ERCs, NIOSH, and other groups and organizations relevant to the Center's mission.

- Management of the Center's website and other communication activities.
- Oversight of the Center-wide interdisciplinary coordination plan.
- Oversight of the Center-wide diversity recruitment plan.
- Compliance with NIOSH reporting and other requirements.

Significant results and key outcomes

Coordination and integration of Center programs and internal/external advisory committees. The ERC's Executive Committee (EC) met monthly during terms and twice in the summer to discuss ERC issues, build consensus, and make decisions to ensure Center-wide coordination and integration. Notes are maintained for these meetings.

The ERC obtained the advice and direction from our *External Advisory Board* (EAB), which historically meets annually or semi-annually with the Program Directors. Sometimes this fall meeting is coordinated with the 1.5 day *Warren Cook Occupational Health and Safety Discussional* (which attracts alumni, practitioners, and our students and faculty to address a wide range of OH&S topics) to facilitate EAB member participation and enrich our ERC activities. We added six new members to the EAB, representing industry, consulting, government, and community organizations. Notes and other materials were maintained for the EAB meetings.

Interdisciplinary and development activities. We conducted planning, developing best-practices guidance, and initiating new content that will dramatically increase our on-line offerings through our new *Michigan-Ohio Occupational Research Education Program* (MOORE), sponsored by the National Institutes of Health (R25 grant) and awarded in October 2021. Involving many faculty and staff from the Michigan ERC, in the next 5 years, we will develop and deliver training and research experiences for students and practitioners in several areas: (1) emerging technologies in exposure assessment; (2) home health care; (3) sustainability and occupational health and safety practices; and (4) ergonomics and aerosol exposure. The highly multidisciplinary team involves also involves experts elsewhere in the University of Michigan, as well as the University of Cincinnati (ERC) and Michigan State University (Occupational Medicine Program).

Managing interactions with stakeholders, other ERCs, NIOSH, and other groups and organizations relevant to the Center Mission. The Center Director represented the Center at the annual meeting of the *Association of University Programs in Occupational Health and Safety* (AUPOHS), which is attended by all the ERC directors or their designates in Washington, D.C. in January or February each year, and the annual *ERC Center Directors* meeting during that period. The Center Director and Center staff also participated in the monthly conference calls conducted by NIOSH. AUPOHS is also meeting monthly now following the monthly NIOSH calls.

ERC Center leadership and the PEC interacted with many groups and organizations relevant to our mission to promote OH&S activities and awareness. Examples include the *Fogarty/NIOSH-supported International Center for the Global Environmental and Occupational Health (GEOHealth) Program*, and the NIEHS-supported *Michigan Lifestage Environmental Exposures and Disease Center (M-LEEAD*). These resulted in co-sponsorship of several outreach events, and opportunities for trainee education and research.

To promote interactions among ERCs in our region, the PEC had monthly conference calls with the *Midwest Regional ERC Consortium*, which involves ERC leadership at Michigan, Illinois-Chicago, Ohio-Cincinnati, and Kentucky (starting fall 2018). This annual symposia series rotated among our four sites, and is attended by ERC faculty, trainees and PPRT recipients. The 2023 Regional Education Research Center (ERC) Symposium, was held on Friday April, 14th at the University of Michigan Union. The 2023 theme "Meeting Challenges in Occupational and Environmental Justice" with guest speakers from EPA, Blue Green Alliance, Green Door Initiative, Boston University, and the Erb Family Foundation. Regional ERC updates on EJ work being done in each state, and afternoon ignite style collaborative workshop and group presentations. This event brought interdisciplinary and intercollegiate NIOSH trainees and faculty together for this yearly scheduled research symposium and poster session from the Education and Research Centers from the University of Cincinnati, University of Illinois Chicago and the University of Michigan.https://cohse.umich.edu/other-events-tours/research-symposium/2023-research-symposium/

Oversight of the Center-wide interdisciplinary coordination plan. The 1.5-year *Interdisciplinary Professional Leadership Fellows Program* organized by the UM Center for Research on Learning and Teaching was completed by four ERC faculty (Center Director Batterman, Occupational Health Nursing Director McCullagh, Occupational Epidemiology Program Director O'Neill, and Industrial Hygiene Program faculty Neitzel). This innovative program is designed to develop health science faculty members' interprofessional education (IPE) and leadership capacity. This team restructured ERC-required course, EHS 668 *Professional Seminars in Occupational Health* to bring together students from all ERC academic programs with practitioners and researchers in the OH&S and to focus on interdisciplinary collaboration, integrating case studies and guest lectures to the curriculum. The team has developed a manuscript on this process, experience and student evaluations, which is in revision for publication in the *Journal of Interprofessional Education.*

We promote interdisciplinary activities among trainees by conducing tours that allow students and staff to visit facilities, such as the *Gordie Howe Bridge* construction site, *Ford River Rouge* Plant or the Detroit *Wastewater Treatment Plant*, to highlight occupational and environmental issues, and engage students in interdisciplinary activities. (Other individuals from UM and the broader public are also invited to participate.) We also initiate and promote other events emphasizing OH&S and interdisciplinary interactions, including seminars and film screenings. During part of the reporting period, these interactions were put on pause due to the pandemic, but they resumed as of Fall 2022.

Oversight of budgets and trainees and reporting obligations. The PEC tracked program and adjusted ERC program budgets to ensure the most effective use of NIOSH support – to attract and train students. We also complied with UM and NIOSH reporting requirements, including progress reports, RPPR, and xTRAIN.

Oversight of the Center-wide diversity recruitment plan. The Center's recruitment plan includes an emphasis on targeting historically Black colleges and universities (HBCUs), tribal colleges and universities (TCUs), and Hispanic serving institutions (HSIs). Center Director Neitzel and Center Deputy Director Batterman served on the EHS Admissions Committee, OSE Director Stirling led the Diversity, Equity, and Inclusion Committee in the Department of Industrial and Operations Engineering, OEE Director O'Neill served as Faculty Lead for the School of Public Health's Diversity, Equity, and Inclusion efforts, and other faculty were also engaged in minority recruitment. Of the 83 MS, MPH and PhD students enrolled in our academic programs, there are currently 8 underrepresented minority students enrolled in the Center's academic core programs.

Program evaluation. We utilized services of professional and external evaluators to assist with program evaluation activities, including the development of logic models for each of the ERC's academic programs and many other aspects. In January 2019, we contracted with the UM *Curtis Center Program Evaluation Group* to continue selected program evaluation activities, specifically, to plan and conduct focus groups with our current students and to conduct phone interviews with alumni in order to (1) evaluate program quality; and (2) understand and aid program recruitment. This activity complements the more comprehensive program evaluation conducted over the 2016-7 period. In December 2021 we contracted with the *UM Center for Research on Learning and Teaching* (CRLT) to update our earlier program evaluation work. CRLT is a larger and highly professional group supported by the UM Provost's office. The final report was submitted to ERC and the EAB faculty in summer and fall 2022, respectively. CRLT had extensive interactions with ERC stakeholders (trainees, faculty, the EAB, and alumni) to develop a comprehensive mixed-methods evaluation of the Center's programming to capture the effectiveness and impact of the Center and its component programs. The evaluation was consistent with guidelines in the 2022 Request for Applications (RFA-OH-23-003), e.g., evaluation questions addressed regional and national needs, interdisciplinary aspects, collaboration with external organizations, undeserved and underrepresented trainees, impact on current and former students, and the preparation of our students. Overall, the CRLT perspective was illuminating, well received, and complementary to our other routine evaluation elements.

Strategic planning. The Center periodically undertakes strategic planning efforts with a five-year time horizon. This plan was last revised in 2017, at which time we also developed an implementation plan. In the current project period, we continued to refine and prioritize elements of that plan, specifically focusing on student recruitment. This led to our ongoing program evaluation effort in this area, as just described. We also considered the development of on-line

programs, and SPH has initiated an online MPH which involves several ERC faculty (e.g., Neitzel, Batterman). An OHS specialty in the online format was considered, but is presently on hold for future years.

Web site, social media, and communications plan. PEC staff maintained and regularly updated our website (cohse.umich.edu). This web site features graphics, videos of our speakers, information on our Continuing Education courses, application materials for the *Pilot Projects Research Program*, banners for current events, and much more. The PEC contracted with a local firm, BoxCar Studio, who are web design experts that assisted with the last major revision of our web site in 2012, to help update the site and add new functionality, including search functions. This work was completed in February 2023.

In the current project period, we developed new brochures on OHS, our programs, and success stories.

In fall 2018, we began creating and distributing a monthly email newsletter to all current ERC students and alumni of the past 2 years. The goal of the newsletter is to centralize information relevant to current and recent ERC students and increase engagement. It contains a *student spotlight*, which highlights the accomplishments of one ERC student per month, *upcoming events*, which showcase relevant OHS events available to students including ERC-sponsored activities, and *opportunities* including grants, pilot projects, internships, job postings, and other positions available for current or past students.

We also maintained an active presence on social media. Events, opportunities, and relevant publications or accomplishments of ERC faculty and students are shared on the Center's Facebook and Twitter accounts. Both accounts posted daily during the academic year to engage current and past students.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

The PEC supports the four academic programs, PPRT, TRT, CE and Outreach cores, and it uses a variety of means to provide training and professional development.

Training and professional development opportunities for trainees in the OE, OSE, IH and OHN Academic Training Programs are described in the respective sections of this final report. Bridging across the four academic programs, the Interdisciplinary and Development aspects of the PEC support training and professional development with the following:

- EHS 668 IOE 837 Professional Perspectives: this course brings together students from all four programs for interdisciplinary interactions, team building, interprofessional development and other purposes. The PEC provides academic support, travel, hosting and Honoria for invited external, and engagement by faculty.
- EHS 510 Responsible Conduct of Research and Scholarship: this course also brings students from the four programs to meet the NIH requirements in this area, and to ensure awareness and professional values in all graduates.
- Regional OHS Symposium: including planning, implementation, evaluation, and funding for travel
- Field trips: which provide trainees with additional opportunities for professional development.
- Informal activities, including "coffee chats," semester start icebreakers and trivia nights; email alerts regarding training and other professional opportunities. These activities were largely halted as in-person gatherings during the pandemic, but began again in Fall 2022.

The PEC also supported the PPRT Program. We required our grant recipients to attend our *Regional OHS Research Symposium*, provide poster/presentations and engage in discussion and networking opportunities. The PEC helps coordinate these activities and supports travel and other expenses.

B.5. How did you disseminate the results to communities of interest?

We supported and referred trainees and staff to professional development seminars, videos and other opportunities offered by University of Michigan and allied schools, pertaining, for example, to grant writing, peer review, mentoring, and responsible research.

A broad audience was reached via our *Outreach* and *Continuing Education Programs*. These reached practitioners, policy makers, and the broader public, and are described in those respective sections.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

The PEC (now referred to as the Evaluation and Planning Core, EPC, for the next reporting period) will continue to monitor, evaluate, and modify our strategies for Center administration and management to assure maximum flexibility and responsiveness to new challenges. Continual refinement of our approach should help to assure strong coordination and integration across Center programs, and better use the advice and guidance of our External Advisory Board. We also anticipate steady improvements in interdisciplinary coordination and success in diversity recruitment.

Specific activities of note will include collection and analysis of information from our alumni and current students; review of the evaluation plan and outcomes; planning for the next regional symposium; and evaluation and refinement of EHS 668 – Professional Seminars in Occupational Health, to examine the effectiveness of the new interdisciplinary components. We also look forward to completion of the external evaluation being conducted of ERC programs by CRLT, as noted earlier. We also will be coordinating new modules on OHS topics as described earlier in the MOORE program.

In the next reporting period, the Center and EPC will maintain its monthly meetings with Program Directors, monthly phone meetings with the regional ERCs; and conduct one in person and one telephone meeting with the EAB. The EPC will continue to support and coordinate all four core academic programs and will continue to develop interdisciplinary and OHS-focused activities, including field trips and research symposia. Special consideration will be given to diversity recruitment over the next project period. Website, social media, and communications will continue as in the past.

Finally, we will help to integrate our new initiatives into the coursework and research experiences of our trainees.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
Cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
RNEITZEL		Neitzel, Richard L	BS,MS,PHD	**PD/PI** (22-23)	0.0	1.2	0.6			
STUARTB	Y	BATTERMAN, STUART A	BS,MS,PHD	**PD/PI** (18-19, 19-20, 20-21, 21-22)	0.0	2.1	1.1			

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?
N/A

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.
N/A

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
N/A

G.2 Responsible Conduct of Research
N/A

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The mission of the Center is to serve the region, nation, and world as a center of excellence for research and graduate education in Occupational Health and Safety (OHS). We serve constituencies including: (1) NIOSH; (2) industry, labor and professional interests in our region; (3) academic units within UM that provide critical teaching and research resources necessary for Center success; (4) our students, including both full time students enrolled in our graduate degree programs as well as those engaged in our continuing education (CE) programs; and (5) the broader public community through outreach and service.

The Center provides NIOSH-supported professional training (Masters of Public Health, MPH; Masters of Science, MS; Masters of Science in Engineering, MSE; and Masters of Nursing, MSN) and research training (Doctoral, PhD) in four

core disciplines: Industrial Hygiene (IH), Occupational and Environmental Epidemiology (OEE), Occupational Health Nursing (OHN), and Occupational Safety Engineering and Ergonomics (OSE).

The objectives of the Planning and Evaluation Core (PEC) include:

- Coordination and integration of the Center programs.
- Assessment of the overall productivity, effectiveness, and need for Center programs.
- Provision of overall organization of Center-wide activities.
- Organization and management of internal and external advisory committees.
- Managing interactions with stakeholders, other ERCs, NIOSH, and other relevant organizations.
- Management of the Center's website and other communication activities.
- Oversight of the Center-wide interdisciplinary coordination plan.
- Oversight of the Center-wide diversity, equity, and inclusion recruitment plan.
- Compliance with NIOSH reporting and other requirements.
- Promoting communications and outreach.

During the reporting period, the EPC conducted many activities to attain our objectives. These included: program planning, implementation and evaluation; strategic planning; program revision, and program promotion. In addition, the EPC helped with updates to training materials, recruitment, budgeting, reporting to NIOSH, XTRAIN reporting, outreach, research-related activities, and planning for our research symposia.

While the COVID-19 pandemic had undesirable but unavoidable impacts on educational programs from early 2020 forward, the PEC successfully pivoted and continued to administered high-quality education and experiences to our trainees.

A. COVER PAGE: INDUSTRIAL HYGIENE

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2022-06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The mission of the Industrial Hygiene (IH) Program is to: 1) provide outstanding, comprehensive graduate-level education in occupational health science to ensure that graduates are qualified to pursue careers and assume leadership roles in the modern practice of industrial hygiene; and 2) mentor those pursuing doctoral level training in research at the cutting edge of the IH field to prepare them for careers in academia or research and development.

The IH Program goals are: 1) to enroll, educate, and support top-quality students from diverse backgrounds, and prepare them to be leaders in the science, practice, and further development of industrial hygiene; 2) to maintain one of the leading graduate IH programs in the world; and 3) to endow our students with the multidisciplinary technical foundations and attitudes necessary to continue to learn throughout their professional careers. The educational objectives are to administer an outstanding educational experience that motivates students toward academic excellence and provides students with a comprehensive program of study that imparts the knowledge, skills, and preparation to:

- Understand the essential scientific and practical elements of the anticipation, recognition, evaluation, management, control and communication of health hazards in the workplace.
- Apply and communicate knowledge of hazards to reduce unsafe exposures and promote healthy working conditions.
- Think critically in defining and solving problems.
- Work effectively in teams with other health professionals and with other stakeholders.
- Embrace the professional, ethical, and leadership responsibilities inherent to the practice of industrial hygiene.

B.2. What did you accomplish under these goals?

Major activities and objectives

IH faculty members continued to teach didactic courses, mentor students and post-docs, direct research, pursue grant funding, publish articles, administer the various aspects of the program, and perform service to the program, department, school, university, local/regional stakeholders, and broader IH community. The specific objectives were to achieve the student outcomes we have defined for the IH program, maintain or improve the quality of our courses and other aspects of the program, execute our continual improvement plan, maintain extramural funding, publish papers, administer the program, recruit students, maintain contact with alumni, and perform service to our various constituencies.

Accomplishments

Our new junior faculty member in the industrial hygiene program has continued to ramp up her research and teaching efforts. Dr. Aurora Le started as an Assistant Professor of Environmental Health Sciences on 1 September 2020. Prof. Le has expertise in the mitigation and management of highly infectious disease, with a particular emphasis on education, prevention, and preparedness. She also conducts research on occupational health disparities, psychosocial factors of work, and the intersection between health behavior and safety. During this reporting period, Prof. Le successfully developed and taught a new industrial hygiene-related course, EHS 592: “Infectious Disease and Emergency Response In Communities.” This course represents a topical area that is new to our industrial hygiene program.

We have assisted NIOSH with the agency’s COVID-19 pandemic response efforts. Profs. Le and Neitzel both engaged in Intergovernmental Personnel Act (IPA) agreements with NIOSH in order to provide technical expertise and guidance to NIOSH in order to promote better workplace protections from the SARS-CoV-2 virus. Prof. Le worked with The Center for Construction Research and Training (CPWR) – a NIOSH-funded center – to develop infographics based on

Frequently Asked Questions about the COVID-19 vaccine, due to low vaccine receipt in the construction industry. The infographics aimed to present scientific research and facts in lay terms and images.

We have maintained our 6-year ABET accreditation. As part of our efforts, we have continued to implement our revised Program Assessment Process and Continual Improvement Plan, which help maintain the high quality of the IH Program.

We have maintained our strong extramurally-funded research program. IH program director Neitzel received an R21 grant from NIOSH ("Exploring the association between occupational noise exposures and injuries"), and the Apple Hearing Study was extended for 3 more years, through 2024. Prof. Meeker leads projects in 2 large, multi-investigator Center-type grants (Superfund Research Program, ECHO), and is currently PI for 2 R01 grants from NIH/NIEHS and Co-I on an additional 3 R01 grants. Prof. Le received a Pilot Project Research Training grant from the UM Center for Occupational Health and Safety Engineering (Evaluating Occupational Biohazards, Stress, and Readiness for Uptake of Total Worker Health Interventions in U.S. Waste Workers) and continues to be the subaward PI for the Prevention, Preparedness and Response (P2R) Consortium, a NIEHS Worker Training Program, delivering biosafety and opioid awareness trainings to nonhealthcare workers.

The *Certificate Degree Program in Risk Science and Health*, launched by Prof. Neitzel in 2012 and directed by him until 2021, has thrived (to date, 16 IH students have earned the certificate). We renamed our annual Warren Cook IH Discussional the *Warren Cook Health and Safety Discussional* in hopes of increasing participation by occupational and environmental health (OEH) professionals.

<u>Trainee Recruitment, Enrollment, Graduates, Placements</u>

Over the reporting period, the IH Program enrolled 40 students (36 MPH and MS students and 4 PhD student, all full time). All eligible MPH/MS students received NIOSH ERC financial support; international students did not. The gender mix was 60%/40% female/male on average and did not fluctuate notably year to year. This gender mix represents more women than historically seen We had an average of 82% US citizens, and 3% of our students were African American, while 15% were of Asian descent, and 10% were of Hispanic/Latino descent.

All MPH graduates completed their required 10-page written reports on their capstone projects and presented their results at the annual *Fall EHS Poster Session*. All MS graduates completed a research thesis, and all doctoral graduates completed a dissertation.

The undergraduate major in Public Health within the UM School of Public Health began in 2018, and we have recruited several students from that program to the IH MPH Program.

Our rates of *placement in internships and jobs* have historically been excellent, and they continued to be so despite the COVID-19 pandemic impacts during this reporting period. Of the 36 MPH and MS students, all secured internships. All but 1 of 31 graduates secured jobs in the field within 4 months of graduation, most within 1 month of graduation; the 1 that did not has chosen to pause her career to have a family. It is gratifying that 97% took IH jobs and of those, 19 (45%) took positions in HHS Region 5, indicating we are meeting regional and national needs.

Incoming students' qualifications have been consistently high for the reporting period. Cohort-averaged undergraduate GPA's ranged from 3.34 to 3.57, and average percentiles for verbal and quantitative GRE scores ranged from 50th to 78th and from 57th to 70th, respectively, in any given year between 2018 and 2020. Compared to the 5-year average GPA for enrolled students from 2012-2017, our 2018-2022 5-year average GPA was very slightly higher. SPH dropped the GRE requirement in 2020 on a pilot basis, and made this change permanent in 2021, so this measure is not available from 2020-2022. Regarding other benchmark measures of effectiveness related to recruitment and student quality, we are doing well in most respects, acknowledging that our minority enrollment is down relative to the previous reporting period. We are close to SPH levels for African Americans, and above SPH levels for trainees of Hispanic descent.

Awards

IH Program students received 25 AIHF scholarship awards, 2 Board of Certified Safety Professionals scholarships, and 1 3M Occupational Safety and Health scholarhips during the reporting period. Our award-winning student association UMIHSA was honored as the best AIHA student local section in 2018 and 2020. UMIHSA won this award 5 times in the past 14 years.

Curriculum and assessment

Several changes/improvements/enhancements to the curriculum were made, and several others formulated and approved for near-future implementation. Prof. Le developed and launched a new course, EHS 592, "Infectious Disease and Emergency Response," which will deliver information relevant to keeping workers safe from infectious diseases in occupational settings and covers aspects of social and occupational justice. Prof. Le has continued to refine her new core course for the industrial hygiene program, EHS 585, "Psychosocial Factors Impacting Occupational Health and Safety." This course leverages Prof. Le's expertise and academic training in health behavior and health promotion, as well as her status as a Certified Safety Professional (CSP) and was well-subscribed and highly-evaluated in its initial offerings. Prof. Le also co-taught a special topics course with Prof. Marie Anne Rosemberg from the Sch. of Nursing who has expertise in community-based participatory research methods. This course, EHS 796, "Healthy and Safe Nail Salon Workers: A Community Outreach Initiative," is an experiential course that engages MPH students in different aspects of this on-going study of Vietnamese immigrant workers and shop owners. The Michigan Healthy Nail Salon Cooperative (MHNSC) co-led by Profs. Le and Rosemberg, the expressed mission of which is to serve owners and workers in nail salons in SE Michigan continued to make progress in the community and afforded students opportunities to contribute this community-based endeavor.

With the retirement of former IH program director. Prof. Tef Zellers in December 2020, Prof. John Meeker refined and taught EHS 652, "Evaluation of Chemical Hazards," a core class in the IH curriculum, beginning in Fall 2021. Center Director Neitzel launched a new course, PUBHLTH 514, "Public Health Sciences in the Environment," in 2019. This course includes occupational health and safety content, and is required for all UM MPH students. He also used the course to create a new online Massive Open Online Course (MOOC) specialization offered through Coursera, which has enrolled over 10,000 learners. Center Deputy Director Batterman initiated a new course in Winter 2020 for doctoral students, EHS 850, "Research Design and Proposal Development in Environmental Health Sciences. Also, he is PI for a new R25 grant entitled Michigan-Ohio Occupational Research and Education Program, which will engage IH faculty to develop new modules and research experiences, in conjunction with other experts at Michigan State University and the University of Cincinnati.

EHS 653, "Environmental Sampling and Analysis Laboratory," and EHS 654, "Control of Exposures to Airborne Contaminants," are being taught by adjunct faculty member Greggory Grubb, CIH. Mr. Grubb took over EHS 653 from Prof. Zellers upon his retirement. A new adjunct faculty member, Brad Burcz, CIH, began co-teaching EHS 757, "Occupational Health Aspects of Industrial Processes," in Fall 2021 along with existing adjunct faculty Bert Schiller, CIH. Another new adjunct faculty member, Jan Lach, PE, CSP, began teaching EHS 651, "Program Management in Occupational Safety and Health." Existing adjunct lecturer Brad Joseph, PE, CIH, continued to teach EHS 556, "Occupational Ergonomics,", and IOE 539, "Occupational Safety Engineering."

All courses offered as part of the IH curriculum received strong evaluation scores during the reporting period, with the exception of the EHS 653 "Environmental Sampling and Analysis Laboratory" course, which was heavily impacted by the pandemic due to its in-person, hands-on nature.

NIOSH funds for training related expenses were used to purchase state-of-the-art laboratory supplies, to support numerous students to (virtually) attend the AIHCE in May 2022, the OSHA 30-hr on-line training over the Winter, 2022 term, and a weeklong HAZWOPER training course in March 2022.

Assessment outcomes

Surveys of stakeholders and alumni were conducted this year at the AIHCE as part of our Program Assessment Process. Among the responses we found several topics not given adequate coverage, including psychosocial hazards, mental health, and infectious diseases. Prof. Le has developed several courses that directly respond to these suggestions.

Student feedback mechanisms included our usual annual sessions held with 1st and 2nd year MPH/MS students on all courses and all organized extra-curricular activities, exit interviews administered by the IH faculty one-on-one, and exit surveys administered by the SPH. The results of these assessments were reviewed, and valid criticisms were acted upon. Most courses were evaluated favorably by the students. Exceptions were acted upon and improved. Most courses were well-attended and many included more than just IH students.

The 2022 Center for Research on Learning and Teaching (CRLT) evaluation report for the IH and other ERC programs (Appendix EPC-1 and section EPC.2.c) provided feedback on issues related to student outcomes. The majority (57%) of IH alumni respondents felt highly or moderately prepared in all general skills and that all general skills were highly or moderately important (73%). They felt most highly prepared to identify and solve problems in occupational health science (77%). Communicating effectively was identified as the most important skill (80%). Most (67%) of IH alumni respondents felt highly or moderately prepared in all program skills, and nearly all (90%) felt all program skills here highly or moderately important. They felt most highly prepared to understand fundamental aspects of safety and environmental health (83%). Recommending and evaluating appropriate controls or other interventions to reduce or eliminate hazards was the most highly important skill (97%).

Faculty Accomplishments

Center Director and IH Program Director Neitzel and Professors Meeker and Le maintained strong extramurally supported research programs. Over the reporting period, they were PI, co-PI, or co-I on 34 extramural research grants amounting to >$60 million in total costs (many of these were/are large grants for which the faculty had/have leading or supporting roles/responsibilities). They have mentored numerous students in research and served as dissertation chairs for 5 doctoral students (from several departments/programs) and primary mentors for 2 postdoctoral fellows. They generated 225 peer-reviewed articles and conference proceedings papers, 2 patents or patent disclosures, published other scholarly publications over the 4-year reporting period, and have delivered numerous invited and contributed presentations at professional meetings in the U.S. and abroad. Prof. and Center Deputy Director Batterman generated additional peer-reviewed papers over the reporting period as well, and mentored several (non-IH) PhD students and postdocs. A significant number of the publications (114/225 = 51%) and presentations by the IH Core faculty were co-authored with Master's or doctoral students advised by the faculty.

The core IH faculty carried loads of 2-4 courses, with evaluations ranging from good-excellent on both the standard university forms and our Supplemental Evaluation Forms, which are competency-based.

Prof. Neitzel has served as Program Director of the IH program since 1 January 2021. He also served as Associate Director of the UM School of Public Health Office of Global Public Health, as well as Director (2022-23) and Deputy Director (2020-2022) of COHSE. He continued to serve as Chair of the ACGIH TLV Physical Agents Committee, and was recently appointed to another 3-year term, ending 2025. He continued to serve as PI of the large-scale, "big data" Apple Hearing Study (funded by Apple Inc., with funding recently extended through 2024) to evaluate the impacts of music and noise exposure on hearing and cardiovascular health in America. He was awarded an R21 grant by NIOSH, "Exploring the association between occupational noise exposures and injuries," to evaluate the relationship between nonfatal and fatal injuries and occupational noise exposures at the national level in the US. He also served as a Co-I on a COVID-19-related study funded by the Ford Foundation, "Social Determinants of COVID-19 in Ford Employees in Southeastern Michigan: A Longitudinal Study." Prof. Neitzel worked in various capacities to support the UM School of Public Health, University of Michigan, and NIOSH (through an IPA agreement) regarding the COVID-19 pandemic and approaches to reduce the risk of SARS-CoV-2 transmission. He also now directs the popular *Certificate in Global Public Health* within the UM School of Public Health. He also received the Michael Beall Threadgill Award for Outstanding Leadership and Service from the National Hearing Conservation Association, and the Edward J Beier Technical Achievement Award from the American Industrial Hygiene Association. He served as primary faculty mentor for Prof.

Le, and will do so throughout her Assistant Professorship. Prof. Neitzel also created a Massive Open Online Course (MOOC) specialization titled "Impacts of the Environment on Global Public Health", that features an emphasis on occupational health. More than 10,000 learners have already enrolled in the MOOC specialization.

Prof. Meeker continued to serve as Senior Associate Dean for Research in SPH, where he oversees the school's research portfolio which totals over $90 million per year. Prof. Meeker agreed to serve as deputy Director of the IH program, effective 1 January 2021. He is Deputy Director and is in charge of the Pilot Grant Program for the UM NIEHS P30 EHS Core Center, and is Associate Director for the UM NIEHS T32 Training Grant in Toxicology and Environmental Epidemiology. He also leads projects in 2 large, multi-investigator Center-type grants (Superfund Research Program, ECHO), and is currently PI for 2 R01 grants from NIH/NIEHS and Co-I on an additional 3 R01 grants. He has served as Co-Chair of the ECHO Chemical Exposures Working Group since 2016.

Prof. Le joined the EHS Department in the 2020-2021 academic year as an Assistant Professor. Starting in the 2021-2022 academic year, she was awarded the John G. Searle Assistant Professorship – an additional appointment of an endowed professorship. She is a subaward PI for a five-year U45 grant through NIH/NIEHS Worker Training Program to provide biosafety, emergency preparedness, and hazardous materials trainings to U.S. workers. She is working to build her research program around infectious disease mitigation and management, as well as research focused on occupational health disparities, psychosocial factors of work, and the intersections between health behavior, occupational health, and industrial hygiene. Additionally, this year she taught the two previously mentioned courses (EHS 592: Infectious Disease and Emergency Response in Communities and EHS 796: Psychosocial Factors Impacting Occupational Health and Safety) that she developed over the course of her first year and through this summer. She also co-taught a seminar titled, "Healthy and Safe Nail Salon Workers: A Community Outreach Initiative".

Former IH Program Director Zellers shifted to emeritus status on 1 January 2021 and spent most of the past reporting period guiding Prof. Neitzel in the activities associated with the IH Program Directorship, which he inherited. Prior to moving to emeritus status, Prof. Zellers work in the development of micro-analytical systems brought advances in new technologies that bear directly on problems related to occupational exposure science and homeland security. His most recent peer-reviewed article described the first-ever wearable microfabricated gas chromatograph (μGC) prototypes, and he worked with a private firm to develop the next-generation μGC prototype under IARPA funding.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

IH faculty and students published extensively and presented at multiple professional meetings (please see pertinent section for this material).

In addition, IH faculty and students participated in several outreach activities (please see Outreach section) and continuing education (please see CE section).

B.5. How did you disseminate the results to communities of interest?

Prof. Neitzel routinely deals with members of exposed/affected communities in Detroit, MI, Gothenburg, Sweden, and in Kalasin, Thailand as part of his research program. In the process he has been able to educate the community members about the hazards they face at work. Similarly, Prof. Meeker's studies of reproductive health outcomes among pregnant women and mothers in Puerto Rico entails education of the study subjects and the surrounding communities of the potential hazards of chemical exposures during pregnancy and way to minimize exposures. We have produced several videos about our work that are accessible via our website to the general public. Prof. Neitzel was interviewed repeatedly by various media outlets on adverse effects of noise exposure, as well as on occupational

exposures and controls relevant to the COVID-19 pandemic. Prof. Le also partnered with nail salons in Ann Arbor to counsel them on health and safety and to make them aware of the research, education, and advocacy efforts of the Michigan Health Nail Salon Cooperative, which she co-leads with another UM faculty member. Prof. Batterman continued his extensive outreach to both governmental and non-governmental organizations in Detroit, Chicago, State of Michigan, Lansing, Chicago and elsewhere. Other outreach and dissemination activities are addressed under the CE Program.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

The IH curriculum is stable after undergoing some changes as a result of accreditation requirements imposed by the *Council for Education on Public Health* (CEPH) on the UM School of Public Health's degree programs, as well as following the transition of Emeritus Prof. Zellers to emeritus status, Prof. Neitzel's subsequent assumption of the IH program directorship and the addition of Prof. Le to the IH program. We have shown compliance with 22 new CEPH-driven core competencies in MPH degree programs, and we continue to meet the accreditation requirements imposed by ABET on the IH program, as well.

With the addition of the new 2-credit course taught by Prof. Le, EHS 796, "Psychosocial Factors Impacting Occupational Health and Safety," we are exploring ways to limit the total number of credits in the IH program to 60, the number of credits required to achieve an MPH in the UM School of Public Health.

We plan to continue development of the IH curriculum as we develop new courses and modify existing courses in response to changing needs of trainees in IH. Profs.Neitzel, Meeker, and Le, along with adjunct instructors Grubb, Burcz, Schiller, Lach, and Joseph will play critical roles in defining new areas of instruction and research.

Our plans during the next reporting period involve ensuring that the UM IH program maintains its internationally recognized leadership in IH education and research by providing high-quality, broad-based academic training in OHS to a diverse and well-prepared student population, mentoring students in cutting edge research in areas of critical need, and ensuring that graduates are qualified to pursue careers and eventually assume leadership roles in professional practice, academia, or at national laboratories. With these goals and our emphasis on preventing disease, promoting health, engaging diverse students in a range of interdisciplinary activities and experiences, and instilling the skills and attitudes required for a productive career in the service of worker populations, the objectives of the IH Program are completely consistent with the broader goals of the UM School of Public Health (SPH), the Department of Environmental Health Sciences (EHS), and the Michigan ERC.

We will continue to offer MPH and MS degrees in industrial hygiene, and a PhD in Environmental Health Sciences with a focus on industrial hygiene. During the next reporting period we intend to recruit and enroll 5-7 new Masters (MPH or MS) students and 1-2 new PhD students per year.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
RNEITZEL	Y	Richard Neitzel	BS,MS,PHD	PD/PI	0	1.2	0.6			NA
MEEKERJ		John Meeker	BS, MS, ScD	Deputy IH Director	0	0.03	0.03			
AURORALE		Aurora Le	BS, MPH, PhD	Associate Professor	0	0.25	0.25			
EZELLERS		Edward Zellers	BS, MS, PhD	Past IH Director	0	1.2	0.6			

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: No
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The Industrial Hygiene (IH) Program has the following training goals:

- to enroll, educate, and support top-quality students from diverse backgrounds, and prepare them to be leaders in the science, practice, and further development of industrial hygiene;
- to maintain one of the leading graduate IH programs in the world; and
- to endow our students with the multidisciplinary technical foundations and attitudes necessary to continue to learn throughout their professional careers.

In achieving these objectives, the Michigan ERC IH Program is enhancing academic and practitioner human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new IH academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and

address traditional and emerging occupational hazards, as well as new IH practitioners who can directly apply the knowledge and skills obtained from the Michigan ERC IH program to promote and protect the health of American workers.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The public health relevance of this training grant is that we have trained multiple students in the field of industrial hygiene, and their research and career trajectories has contributed to the overall goal of improving occupational safety and health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
N/A

G.2 Responsible Conduct of Research

The faculty ensure the highest level of integrity and ethical conduct in the execution of research under their supervision. The IH Program uses the following elements to codify such conduct and instill this training and awareness. Trainees much complete each of the following, typically in their first term of training.

EHS 510 - *Responsible Conduct of Research and Scholarship.* RCRS training is mandatory for all ERC-supported IH trainees, regardless of whether they will actually conduct research. RCRS training requires attendance and participation in a sequence of 11 1-hour modules taught by faculty that address: (1) Research and Academic Misconduct - Fraud, Fabrication, and Plagiarism; (2) Intellectual Property - Data Storage and Ownership; (3) Responsible Authorship and Publications - Peer Review; (4) Human Subjects Research and IRBs; (5) Animal Use and Care - Laboratory Safety and Responsibilities; (6) Mentor/Mentee Relationships; (7) Conflict of Interest - Personal, Professional, and Financial; and (8) Research and Scholarship in Society and in the Global Workplace; (9) Rigor and Reproducibility; Introductory and Summary modules bookend these modules. In addition to the 9 modules, the course utilizes an introduction or orientation session, and the course terminates with a concluding and debriefing session. At these sessions, trainees' understanding of topics in the ethical conduct of research is probed; trainees complete anonymous (pre- and post-course) surveys, and course strengths, weaknesses and potential improvements are discussed. In addition to the surveys, other evaluation mechanisms for this course include the usual UM end-of-

term course evaluations, and a brief interactive survey conducted after every 2 or 3 modules. This information is consolidated, sent to the EHS 510 instructors, and used to improve the course, including the selection of instructors used for the 9 modules.

EHS 510 is limited to small (10-20 students) groups of students for face-to-face discussion led by experienced faculty. The faculty include trainee advisors. The total number of hours of instruction in the course is 12 hours (8 modules at 1 hour each, module 9, which is normally 2 hours, and introductory and conclusion session each with self-assessments at 1 hour each). This training complements, but does not substitute, for required PEERRS training (described below). It must be repeated every four years.

Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS). We require two of these newly revamped online UM courses (https://research-compliance.umich.edu/peerrs-portal/), *Responsible Conduct on Research and Scholarship* and *Research Administration*, for all ERC-supported IH trainees, regardless of whether they will actually conduct research. A third module, *Human Subjects Research Protections*, is required only for trainees who will conduct research with human subjects. These courses and their corresponding certification tests are designed to improve knowledge and awareness of responsible research practices. In brief, the first course on *Responsible Conduct on Research and Scholarship* encompasses the 9 modules described above for EHS 510. The second course on *Research Administration* deals with legal and ethical requirements of researchers as they relate to authorship and intellectual property (e.g., conflict of interest, data ownership, COI, misconduct, and other topics). The third course on *Human Subject Research Protections* deals with regulatory and ethical underpinnings of the policies that guide Institutional Review Boards (IRBs) and its policies and procedures, including why human research is regulated, with emphasis on the regulatory and ethical responsibilities of the Principal Investigator, IRBs, and university. These three modules require ~7 hours (roughly 4, 1.5 and 1.5 hours, respectively). Certification tests are embedded and must be satisfactorily completed before progressing on and completing each course.

Additional courses in PEERRS may be required depending on the nature of the research. All IH faculty are required to pass PEERRS tests before mentoring NIOSH trainees, and all students must pass the relevant PEERRS certification tests prior to engaging in research. IH students send electronic PEERRS completion certificates to the EHS Graduate Program Coordinator, where they become a prerequisite for graduation.

Institutional Review Board. All students engaged in research involving human subjects are required to submit their proposals to one of the UM *Institutional Review Boards* (IRB) for review and approval. Often, students work with faculty mentors to develop research protocols, write informed consent documents, prepare IRB applications, and then collect human subjects data. Trainees often play a significant role in completing the IRB application in conjunction with the research projects required for their degree.

Other doctoral seminars (for Ph.D. students) are required that explicitly address research integrity and ethics.

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

N/A

G.4.b Inclusion Enrollment Data

N/A

G.4.c ClinicalTrials.gov

N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR

3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets.

Note: project outcome information will be made public in NIH RePORTER

In its 79 years of operation, the Michigan IH program has produced more MS/MPH and PhD graduates than any other US IH program, currently totaling 905, including 40 graduates during the 2018-2023 cycle. Among its former faculty and students the program boasts 13 former Presidents of the American Industrial Hygiene Association (AIHA) and two Assistant Secretaries of Labor for OSHA (Pendergrass and Henshaw). Additionally, it has conducted its annual Warren Cook Occupational Health and Safety Discussional for 60 years, and has been a major center for IH education, research, and leadership over its entire history. The program currently has three core faculty members (ERC Director Rick Neitzel, IH Associate Director John Meeker, and Prof. Aurora Le) and one emeritus member (Prof. Emeritus Ted Zellers).

We are pleased to report a number of outstanding accomplishments in student enrollment and awards, faculty promotions and productivity, curricular enhancement, and other relevant areas, many of which were direct outcomes of ERC activities and NIOSH support. We continue to benefit from major renovations (2006-8 and 2010-12) in the School of Public Health (SPH) buildings, offices, study areas, and laboratories. We have maintained our ABET accreditation (renewed in August 2019) and are applying for re-accreditation in 2024; as part of this, we have maintained our Program Assessment Process, which facilitates achievement of educational objectives and program outcomes and ensures continual improvement of the IH program. One of the current three core IH faculty (Prof. Neitzel) was promoted, and a transition in leadership occurred in January 2021 (from Prof. Emeritus Zellers, who directed the program for 21 years, to now-Center Director and IH Director Rick Neitzel). Enrollment reached an all-time high (21 1st- and 2nd-year trainees) during the current cycle, and our graduates obtained positions in the field to meet regional and national needs for well-trained professionals. Several new required or elective EHS courses taken by IH students have been developed and offered. NIOSH training funds were used to purchase state-of-the-art laboratory supplies and equipment for the IH laboratory course and to support numerous students to attend the AIHce, a week-long HAZWOPER training, and an OSHA 30-hour general industry certificate course each year. The majority of training grant funds were used to pay for student tuition and stipends to ease the burden of the costs of a quality education and reduce barriers in training high-quality IH professionals.

It is worth noting the undesirable but unavoidable impacts of the COVID-19 pandemic on educational programs. Despite these impacts, the IH program continued to successfully deliver high-quality education and experiences to our trainees.

A. COVER PAGE: OCCUPATIONAL & ENVIRONMENTAL EPIDEMIOLOGY

<table>
<tr><td colspan="2">Project Title:
OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)</td></tr>
<tr><td>Grant Number: 5T42OH008455</td><td>Project/Grant Period: 07/01/2018 - 06/30/2023</td></tr>
<tr><td>Reporting Period: 07/01/2018 - 06/30/2023</td><td>Date Submitted: 10/30/2023</td></tr>
<tr><td>Program Director/ Principal Investigator
RICHARD NEITZEL, BS MS PHD
Phone Number: 734-763-2870
Email: rneitzel@umich.edu

OEE Program Director:
MARIE O'NEILL, BA MS PHD
Phone Number: 734-615-5135
Email: marieo@umich.edu</td><td>Administrative Official Information

ELIZABETH HOWARD
3003 S. State St
Ann Arbor, MI 48109

Phone number: 734-764-7234
Email: howardel@umich.edu</td></tr>
<tr><td>Change of Contact PD/PI:
No</td><td></td></tr>
<tr><td>Human Subjects:
No</td><td>Vertebrate Animals:
No</td></tr>
<tr><td>hESC:
No</td><td>Inventions/Patents:
No</td></tr>
</table>

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The Occupational & Environmental Epidemiology (OEE) Program has the following training objectives:

- To integrate the curricula, faculty, and trainees in the Departments of Environmental Health Sciences and Epidemiology for the purpose of strengthening the curriculum and the educational experience of our students.
- To strengthen training in occupational epidemiology methods.
- To recruit an outstanding class of master's level students, and to train them for professional careers in occupational epidemiology through didactic instruction, field experiences, and interdisciplinary interaction.
- To recruit outstanding doctoral students in occupational epidemiology, give them outstanding didactic instruction, mentor them in the conduct of original research, and prepare them for research careers in occupational epidemiology.
- To recruit trainees from underrepresented racial and ethnic groups.

B.2. What did you accomplish under these goals?

Enrollment, Student Research and Curriculum

In the total project period we enrolled 44 students (30 master's and 14 doctoral) in OEE. The percent of masters students during the period who are underrepresented minority students was 33%, compared to 9% in the prior project period. Several of our graduated doctoral students, including Zoey Laskaris, Katrina Burns, and Chanese Forte, worked or are working in the occupational field. Our research program continued with outstanding productivity both in terms of publications and supported projects.

The OEE curriculum continues its strengths in field training, and our master's trainees are required to complete a field experience during the summer between their first and second years. Examples of field experiences over the project period include work on: risk factors for adult diabetes in the Richmond Stress and Sugar Study; research with Mt. Sinai on World Trade Center first responders, research in Uganda on access to clean drinking water; an Occupational Health Internship Program (OHIP) project in Washington, DC; community-based participatory research on energy efficiency in low and middle income housing in Detroit; a research project in Chile as part of the Minority International Health Research Training (MHIRT) program; work on occupational and environmental exposures and global cancer, research on occupational exposures and health in a consulting company, and research on occupational health among nurses in Pakistan.

We have continued to revise and improve the OEE curriculum in response to new opportunities as well as the accreditation process. Everything is going smoothly with the OEE MPH degree which is now offered only through the Department of Epidemiology. OEE Co-Director Dr. Alexis Handal (Epidemiology) has continued teaching Occupational-Environmental Epidemiology, EHS/EPID 608, with an enhanced emphasis on critiques of original articles and a diverse range of guest speakers, including Sheldwin Yazzie speaking on mining-related exposures on the Navajo Nation and Lorena Estrada-Martinez speaking on environmental and occupational exposures on the island of Puerto Rico. The course EHS/EPID 675 Advanced Environmental Epidemiology Data Analysis continues to be offered in the Winter session each year by Dr. Park.

The introduction of inter-professional education (IPE) approaches to the required winter term seminar for all NIOSH ERC trainees, including our OE students, continues to go well. Dr. O'Neill has taught the course this with co-instruction by engineering faculty, including Clive D'Souza and Robert Fox. We continue to enjoy the participation of multi-disciplinary Michigan hospital infection prevention staff as clients for the IPE case studies. Each year they have assigned case studies on current issues they address, including water quality in health care, dealing with ongoing construction projects in the hospital complex; assuring occupational safety after critical incidents, and doing air

assessments when airborne spread of disease is suspected. Students work on these case studies in interprofessional groups. A diverse set of speakers representing nursing, engineering, industrial hygiene and epidemiology are lined up for after the case study presentations. The manuscript on our experiences integrating IPE into the occupational health and safety course was published in Occupational and Environmental Medicine in 2022.

These developments have continued to enhance the training in epidemiology methods as well as interprofessional approaches to address occupational safety and health issues, and to give the students practical experience in the conduct of occupational epidemiology, which reinforces their didactic training.

All OEE trainees are required to complete the Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS), a web-based instruction and certification program for all members of the University of Michigan community engaged in or associated with research. The five required modules include 20-30 web pages containing core material, case studies, questions, and pop-ups with additional information to provide greater depth and elaboration.
The five modules are:
1) Foundations of Responsible Research Conduct (publication/authorship, intellectual property, conflict of interest, signatures, plagiarism, misconduct reporting);
2) Research Administration (UM procedures/forms, PI responsibilities, pre- and post-award activities, federal regulations, important contacts);
3) Conflict of Interest (definitions and recognizing potential conflicts, responsibilities toward students/colleagues, consulting and conflict of commitment, sponsored project and technology transfer issues);
4) Human Research (basic module provided in three versions -- clinical research, health sciences and social/behavioral sciences, with definitions of human subjects research, why human subjects research is regulated, regulatory and ethical responsibilities of the PI, IRB, and University); and
5) Animal Research (principles and regulations for animal care and use, regulatory and ethical obligations of researchers, reporting requirements, obtaining approval).

After completing each module, trainees must achieve PEERRS certification (valid for three years), which is based on passing a short test associated with each topic with a score of 80% or better. The Human Subjects modules require a score of 100% to pass. In addition, all doctoral students and masters students who receive federal funds spend 9 hours of Responsible Conduct of Research and Scholarship (RCRS) in small groups with faculty reviewing these and related ethical and practice topics.

These curriculum changes have strengthened the training in epidemiology methods as well as interprofessional approaches to address occupational safety and health issues, and give the students practical experience in the conduct of occupational epidemiology, which reinforces their didactic training.

Research
Our research program continued with outstanding productivity both in terms of publications and supported projects and with active engagement of OEE students with OEE faculty research. OEE students participate in the departmental poster sessions, which is one of the highlights of the students' experience, bringing students together to discuss their research and to learn research approaches in other disciplines.
Highlights of OEE faculty research include:

Marie O'Neill, PhD, continues to engage in funded research in climate change and health with an emphasis on occupational and environmental justice, co-leads an R25 to enhance diversity in EHS, and mentors postdoctoral fellow Lisbeth Iglesias-Rios and collaborates on the Michigan Farmworker project. In the past period she has been primary or co-mentor of PhD students with occupational epidemiology interests (Zoey Laskaris, Katrina Burns, Sarah Lyon-Callo).

Alexis Handal, PhD, Associate Professor in the Department of Epidemiology, joined the ERC as Associate Director for OEE in 2022. Her recruitment from the faculty at University of New Mexico where she taught for eleven years before coming to University of Michigan in 2019 was purposeful to address the need for more OEE mentors with focus on

occupational epidemiology within our center. Her NIH-funded research on occupational and social determinants of health among marginalized and vulnerable populations, including the impacts of the flower industry export industry in Ecuador among pregnant women both working in the industry and living in the community. She has initiated a new study on social and occupational exposures among Michigan farmworkers (the Michigan Farmworker Project) with funding from NIOSH, NIEHS and the state of Michigan and is publishing on this with Dr. O'Neill, Dr. Iglesias-Rios, and community partners.

Sung Kyun Park, ScD, who served as OEE Co-Director until 2022, continues to strongly enhance the program's presence and expertise in the field and serves as track lead for the OEE MPH students in epidemiology, organizing social events, peer mentoring, and keeping in regular contact with the students via email. He offers expertise in research on health effects from exposures to legacy pollutants, noise, air pollution, and such chemicals as bisphenol A, with focus on the aging process, and continues to offer students opportunities to address occupational exposures and health outcomes in the multiple cohorts with which he works, including the Study of Women Across the Nation. He has a robust program funded research in these areas.

Sara D. Adar, ScD Associate Professor has expertise in research on health effects from exposures to noise and air pollution and evaluation of interventions to reduce pollution exposure. She has recently been awarded significant amounts of funding to study long-term impacts of air pollution on cognitive function in multiple international cohorts from the National Institute on Aging. She has received other funding to explore environmental, social and occupational determinants of dementia, Alzheimer's disease and cognitive decline. Some of her work addresses racial inequities in social adversity and vulnerability to air pollution.

Kelly M. Bakulski, PhD, continues her research on combined genetic and environmental risk, with a focus on neurological outcomes from environmental and occupational exposures. She has acquired a range of funding for this work including a Multi-PI grant with fellow OEE faculty Sung Kyun Park. She has mentored OEE masters papers during this period and continues her dynamic research and teaching programs.

Miatta A. Buxton, MPH, PhD, is Assistant Research Scientist in Epidemiology. She has received excellent reviews for her teaching PH 512, Principles of Epidemiology for Public Health, a core requirement for all masters students at SPH, in which our IH students enroll as well as EPI 643, Epidemiologic Surveillance for Public Health. She continues with research evaluating mechanisms behind air pollution's impact on reproductive health and outcomes.

Bhramar Mukherjee, PhD has continued her active leadership and research program and was elected to the National Academy of Sciences this last year in recognition of her contributions to the field. She has also been renewed on an R25 training grant that invites diverse students to learn about data science, thus enhancing DEI in this field.

Thomas Robins, MD, Professor in EHS and advisor to several OEE trainees, has worked with multiple ERC trainees on occupational research, notably Zoey Laskaris. He has many occupational publications produced with his Ghanaian Co-PI Julius Fobil, students, and colleagues, from a five-year project, The West Africa-Michigan CHARTER II for GEOHealth. The publications and ongoing collaboration show evidence of achievement of the goal of that effort: "to build upon long- standing, extensive occupational and environmental health (OEH) research and training collaborations between academic and government partner institutions in Ghana, as well as other countries of West Africa (WA), and the University of Michigan … so as to sustainably enhance capacity for world-class scientific research and research training which address and inform key national and regional occupational and environmental health priorities and policies".

Additionally, the OEE program benefits from extensive training and research interactions with other ERC faculty, for example, in EHS, Drs. Rick Neitzel, Stuart Batterman, and John Meeker provide exposure assessment expertise, training and support for several epidemiological studies.

Changes in OEE affiliate faculty

Dr. Laura Rozek, PhD, a cancer epidemiologist and Professor, moved to a new faculty position at Georgetown University in fall 2022. She had been an active researcher and mentor to OEE students and sponsored numerous internships to work on occupational health and cancer epidemiology in Thailand and Detroit. She will be missed.

Dr. Siobán Harlow, PhD, a reproductive epidemiologist who has worked on occupational exposures to pesticides and other substances, retired in May 2022. However, she remains the Director of the Center for Midlife Science and remains committed to providing mentoring support to student trainees, particularly those from under-represented backgrounds.

Dr. Alfred Franzblau, an occupational physician, retired from the EHS Department in May 2022 as well. Over the years he has mentored multiple OEE students on occupational health research projects including studies on mercury exposure among dental professionals. Both he and Dr. Harlow maintain Emeritus/Emerita Professorships, reflecting their ongoing involvement in research.

Overall, we have a strong faculty presence in occupational and environmental epidemiology and have achieved a high degree of integration across the two departments.

Outreach

In collaboration with the NIEHS P30 Center based in EHS, we have run a series of Environmental Research seminars which serve as a venue for OEE faculty and students to share their on-going projects.

Notable seminars over the five year period include:

- Identification of occupations susceptible to high exposure and risk associated with multiple toxicants: National Health and Nutrition Examination Survey 1999-2014, Vy Kim Nguyen, October 12, 2021.
- Sustaining a Healthy Nail Salon Workforce in Michigan, Aurora Le, Marie-Anne Rosemberg, November 23, 2021.
- Marie-Anne Rosemberg, Impact of COVID-19 on Service Workers: Work Experiences & Concerns of food retail, food services, and hospitality workers, November 24, 2020
- Ted Zellers, Wearable Microsystem for Direct Measurement of Multi-VOC (Worker) Exposures, October 6, 2020
- "Bruce Tonn (Founder and CEO, Three3, Inc. TN) "Health & Household-Related Benefits of Weatherizing Low-Income Homes & Affordable Multifamily Buildings" October 1, 2019.
- Jack D. Spengler (Harvard University) "Health, Nature and Our Built Environment: Change through Radical Collaborations" October 2, 2019.
- Betsy Wasilevich (Senior Epidemiologist, Michigan Department of Health and Human Services) "PFAS in MICHIGAN: the state of Michigan's investigations and response". November 19, 2020.
- Ivo D. Dinov (Computational Medicine and Bioinformatics, UM Medical School) "SOCR DataSifter: A Statistical Obfuscation Technique enabling Effective Data Sharing" December 3, 2019.
- Jaclyn Goodrich, PhD (Research Assistant Professor, Environmental Health Sciences, UM SPH) Environmental Exposures, Epigenetics, and Health in Vulnerable Populations, Feb 25, 2020

Additionally, a one-day symposium was put on 'From PBB to PFAS: Research and Action to Address Michigan's Large-Scale Chemical Contaminations' on Feb. 20, 2020.

- "Intervention to reduce gymnast exposure to flame retardants" by Dr. Courtney Carignan (Assistant Professor of Food Science & Human Nutrition, Pharmacology & Toxicology, Michigan State University);
- "Community-Academic collaboration on drinking water contamination by perfluoroalkyl substances (PFAS) in the Cape Fear River Basin, NC" by Jane Hoppin (Deputy Director, Center for Human Health and Environment, North Carolina State University) and Kemp Burdette (Cape Fear River keeper, Cape Fear River Watch);
- "PFAS: Evidence of residential segregation and non-linear dose-responses" by Sung Kyun Park.

We also had a film screening event regarding PFAS exposure in DuPont workers and community residents in Parkersburg, WV, "The Devil We Know", which was followed by a panel discussion featuring several OEE faculty along with officials from State government and the local water treatment facility.

Trainee Recruitment

The OEE program continues to recruit students using word of mouth, web-based approaches, and virtual prospective student days. We continue to develop the OEE website within the UM School of Public Health website and link it to many related sites within the University of Michigan, including the ERC, Toxicology, Environmental Science, and Epidemiology websites. We believe that our website is now the principal portal through which applicants learn about our training program. In addition, we maintain traditional recruiting approaches including advertising in professional journals; printed materials sent to undergraduate colleges, universities, alumni, business, and contacts; and listing our program in traditional graduate school directories such as Peterson's Guide to Graduate schools. We actively recruit racial and ethnic minority students and our recruiting materials emphasize this commitment by the University of Michigan. Our website provides links to student organizations at the SPH that play critical roles in recruiting and retaining minority graduate students including La Salud (a resource for leadership and professional development for Latino/a students) and Public Health Students of African Descent (PHSAD) (a resource for African American students).

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

Faculty Development

OEE faculty, including Drs O'Neill, Handal, Park, and others, participate in many activities of the NIEHS P30 center, which runs environmental research seminars that serve as a venue for OEE faculty and students to learn about and discuss relevant research projects. In 2020, OEE Director O'Neill participated in an 18-month leadership "train-the-trainer" program in interprofessional education, a part of the Center for Research on Learning and Teaching at UM, and the skills developed there continue to be applied in the seminar she co-teaches with engineering faculty.

Training Activities

In addition to the course work and research training described in Accomplishments, OEE students attended a number of workshops, conferences, and seminars, including national and international meetings.

B.5. How did you disseminate the results to communities of interest?

OEE faculty and students published extensively and presented at multiple professional meetings (please see pertinent section for this material).

In addition, OEE faculty and students participated in a number of outreach activities (please see Outreach Component)

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

The mission of the UM Occupational and Environmental Epidemiology (OEE) Program is to provide graduate training that will equip talented students of diverse backgrounds to practice and apply occupational and environmental epidemiology skills, with particular emphasis on training students in interdisciplinary teams. Such teams usually yield the most effective solutions to occupational health and safety challenges, and which reflect typical real-world circumstances of future employment.

The single, interdepartmental OEE MPH program initiated for students entering Fall of 2020 has been doing well, with a robust class of six current students and 9 incoming for fall. We will continue to encourage field experience applications to programs including the OHIP internship to enhance training in this domain. We will continue to strive for having a unified and coordinated curriculum and mentoring approach in order to grow the program.

We plan to continue development of the OEE curriculum as we develop new courses and modify existing courses in response to changing needs of trainees in OE and the need to have a streamlined consistent program for all students in this area. Drs. O'Neill, Park, Handal, Adar, Bakulski, Buxton, and Mukherjee will play critical roles in defining new areas of instruction and research.

Training graduate students in occupational epidemiology promises to equip a new generation of professionals with the interdisciplinary skills to:

- Conduct research into the causes of occupational illnesses and injuries;
- Develop & maintain surveillance systems for monitoring occupational illnesses & injury rates;
- Develop new methods for conducting epidemiologic studies of occupational health risks;
- Address issues in genetic testing of workers exposed to hazardous materials, and biosampling and repositories for workers, particularly those most vulnerable or marginalized; and
- Participate in the prevention of injuries and illnesses at work.

This skill set of occupational epidemiology professionals is complementary to those of the other disciplines represented in the Michigan ERC's Academic Programs, namely, Occupational Safety Engineering (OSE), Industrial Hygiene (IH), and Occupational Health Nursing (OHN).

At UM, the training programs and research that cover OE have been traditionally referred to as Occupational and Environmental Epidemiology (OEE). Several academic institutions have departments of occupational and environmental health and courses addressing both occupational and environmental exposures. This combination of the terms recognizes the common origins of workplace and community exposures, the common methodologies used in studying them, the relevance of findings from environmental epidemiology to occupational health and vice versa, and the concept of Total Worker Health® which recognizes that out-of-workplace exposures affect worker health as well.

OEE research at UM has been ongoing for over 30 years through the efforts of a multi-disciplinary faculty versed in occupational health, epidemiology, ergonomics, industrial hygiene, biostatistics, and environmental sciences. Formal programs offering students the opportunity to pursue graduate degrees in OEE have been in place for 21 years, and have received NIOSH funding for 18 years, since July 2004. Over this time, the OEE Program has been highly productive in terms of student recruitment, training, and research. The OEE Program is led by Dr. Marie O'Neill, an epidemiologist and Professor jointly appointed in the Environmental Health Sciences (EHS) and Epidemiology (EPID) Departments in the School of Public Health (SPH), with Associate Professor Dr. Alexis Handal (appointed in Epidemiology) as Associate Director.

We plan to continue to offer the Masters of Public Health (MPH) degree in OEE through the Department of Epidemiology as well as doctoral (PhD) degrees in OEE through both the Departments of Environmental Health Sciences and Epidemiology. The current application has substantially enhanced the leadership, organization and breadth of faculty involvement, as well as the coordination across the departments. Notably, after feedback that offering of the OEE MPH through both departments with small differences in focus was at times a confusing experience for students, we standardized the degree requirements and now offer the degree only through the Department of Epidemiology starting in fall 2020. This consolidation involved a thorough review of the curriculum, a proposal to harmonize it, a vote in favor from both departments, and a formal memorandum of understanding between the two departments delineating the process for reviewing applications, admitting students, offering NIOSH training grant support, and supporting and mentoring students through their degree programs.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
MARIEO	Y	Marie, Sylvia O'Neill	BA,MS,PHD	Co-Investigator	0.0	0.6	0.4			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The Occupational & Environmental Epidemiology (OEE) Program has the following training objectives:

- To recruit an outstanding class of master's level students, and to train them for professional careers in occupational epidemiology through didactic instruction, field experiences, and interdisciplinary interaction.

- To recruit outstanding doctoral students in occupational epidemiology, give them outstanding didactic instruction, mentor them in the conduct of original research, and prepare them for research careers in occupational epidemiology.
- To recruit trainees from underrepresented racial and ethnic groups.

In achieving these objectives, the Michigan ERC OEE Program is enhancing academic and practitioner human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OEE academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards, as well as new OEE practitioners who can directly apply the knowledge and skills obtained from the Michigan ERC OEE program to promote and protect the health of American workers.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The public health relevance of this training grant is that we have trained multiple students in the field of occupational and environmental epidemiology, and their research and career trajectories has contributed to the overall goal of improving occupational safety and health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research

Faculty actively participate in responsible conduct of research training for OEE students, which takes place online, in the classroom, through direct mentoring, and in seminars. OEE students at the MPH and PhD levels (and future postdoctoral OEE Fellows) typically take a course at the School of Public Health (SPH) currently coordinated by ERC Deputy Director Prof. Stuart Batterman, EHS 510.

EHS 510 - *Responsible Conduct of Research and Scholarship (RCRS).* Trainees must attend and participate in 11 1-hour modules taught by Dr. Batterman and other faculty that address: (1) Research and Academic Misconduct - Fraud, Fabrication, and Plagiarism; (2) Intellectual Property - Data Storage and Ownership; (3) Responsible Authorship and

Publications - Peer Review; (4) Human Subjects Research and IRBs; (5) Animal Use and Care - Laboratory Safety and Responsibilities; (6) Mentor/Mentee Relationships; (7) Conflict of Interest - Personal, Professional, and Financial; and (8) Research and Scholarship in Society and in the Global Workplace; (9) Rigor and Reproducibility; (10) Introduction and (11) Summary modules which occur at the beginning and end of the 9 substantive modules. Trainees are evaluated on their understanding of topics in the ethical conduct of research. They also complete anonymous surveys, and course strengths, weaknesses and potential improvements are discussed. In addition to the surveys, other evaluation mechanisms for this course include end-of-term course evaluations, and a brief interactive survey conducted after every 2 or 3 modules. This information is shared with EHS 510 instructors and used to improve the course.

EHS 510 provides groups of 10-20 students with in person discussion opportunities led by experienced faculty from SPH and sometimes faculty from other units; faculty include trainee mentors. The total number of hours of instruction in the course is 12 hours (8 modules at 1 hour each, module 9, which is normally 2 hours, and introductory and conclusion session each with self-assessments at 1 hour each). This training complements required PEERRS training (described below), and must be repeated every four years if a student's tenure lasts that long.

Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS). We require three of these on-line UM courses as part of the RCRS training (https://research-compliance.umich.edu/peerrs-portal/): *Responsible Conduct on Research and Scholarship*, *Research Administration*, and *Human Subjects Research Protections*. These courses and their corresponding certification tests are designed to improve knowledge and awareness of responsible research practices. The first course on *Responsible Conduct on Research and Scholarship* addresses, in complementary fashion, topics in the 9 modules described above for EHS 510. The second course on *Responsible Research Administration* deals with legal and ethical requirements of researchers as they relate to authorship and intellectual property (e.g., conflict of interest, data ownership, misconduct, conflict of interest and other topics). The third course on *Human Subject Research Protections* addresses regulatory and ethical underpinnings of the policies that guide Institutional Review Boards (IRBs) and its policies and procedures, including why human research is regulated, with emphasis on the regulatory and ethical responsibilities of the Principal Investigator, IRBs, and university. These three modules take approximately 7 hours to complete (roughly 4, 1.5 and 1.5 hours, respectively). Certification tests are embedded and must be satisfactorily completed before progressing on and completing each course.

Additional courses in PEERRS may be required depending on the nature of the research in which trainees participate. All faculty are required to maintain PEERRS certification when mentoring NIOSH trainees, and all students supported by ERC funds are required to pass the relevant PEERRS certification tests prior to engaging in research. Students send electronic certificates indicating completion of the PEERRS courses to the OEE Program Director, where it becomes a prerequisite for graduation.

Institutional Review Board. All students engaged in research involving human subjects are required to submit their proposals to one of the UM *Institutional Review Boards* (IRB) for review and approval. Often, students work with faculty mentors to develop research protocols and related documents, prepare IRB applications, and then collect human subjects data. Trainees often play a significant role in completing the IRB application in conjunction with the research projects required for their degree.

Other professional development courses Doctoral seminars (for Ph.D. students) are required that explicitly address research integrity and ethics.

Faculty experienced in research design and conduct lead and evaluate all student learning experiences.

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The OEE Program in the ERC at the University of Michigan began in 2004. Our graduates have transitioned into a wide variety of positions in the private sector, government, fellowships, PhD training programs (in the case of MPH students), and medical school. From July, 2018 to June, 2023, we enrolled a total of 30 Masters students and 14 Ph.D. students, with 25 of the MPH and 7 of the PhD students being NIOSH supported.

Our master's trainees are required to complete a field experience during the summer between their first and second years. Examples of field experiences during this period include an occupational health internship in Chicago addressing concerns of temporary workers; an occupational health internship in Maryland with the Association of Occupational and Environmental Clinics United Food and Commercial Workers Local 1994 to improve health and safety for their members who work in a beverage warehouse and a waste-transfer facility; research at Mt. Sinai in New York on occupational health concerns of World Trade Center first responders; collaboration with the climate change and health group in the Michigan Department of Health and Human Services in creating a state report on climate impacts on health, and internships with epidemiology teams at local health departments.

We have continued to strengthen our faculty in occupational and environmental epidemiology and better integrated the Departments of Environmental Health Sciences and Epidemiology offerings in occupational epidemiology.

A. COVER PAGE- OCCUPATIONAL HEALTH NURSING (OHN)

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **OHN Program Director:** MARIE-ANNE ROSEMBERG, PhD, MN, RN, FAAOHN Phone Number: 734-647-0146 Email: sanon@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The mission of the Michigan OHN Program is to prepare advanced-level OHN specialists and leaders with expertise in professional practice, administration and management, and program development and evaluation. To meet this goal, program faculty recruit highly qualified students, engage in discovery to advance the OHN knowledge base, and perform service at local, regional, national, and international levels. The specific goals to accomplish this mission are:

1. Prepare a diverse pool of advanced-level OHN specialists and leaders with expertise in professional practice, administration and management, and program development and evaluation.
2. Provide NP graduates with advanced clinical skills to diagnose and treat work-related injuries and illnesses in collaboration with other core OHS disciplines.
3. Prepare skilled researchers and educators with specialization in OHN.
4. Promote OHN education in undergraduate and graduate courses in other departments and other schools in the region.
5. Participate with the ERC in offering high-quality Continuing Education (CE) programs.
6. Maintain a high level of interdisciplinary interactions between and among ERC students and faculty.

B.2. What did you accomplish under these goals?

Graduates. Since 2018, we have graduated 20 specially trained (MSN, DNP) OHNs who have gone on to promote the health of workers in hospital based OH clinics, public and private industry, and clinics providing services to businesses.

Enrollment. As of fall, 2022, the program enrolls 9 students, with 4 new matriculates in Fall, 2022 (2 matriculated in winter 2023). Enrollment averaged 9 students per year (range 7-12 students per year), and 13 Masters and 6 students graduated. Student distinctions included Nathan Stefanovsky receiving the Sigma Theta Tau International Honor Society of Nursing Rho Chapter Evidence-based Practice Award, and Laura Ridge receiving the UM African Social Research Initiative Award. Graduates achieved high rates of Nurse Practitioner certification within one year of graduation.

We continue active recruitment targeting the enrolled UMSN graduate students. We provided nurse practitioner trainees with advanced clinical skills to diagnose and treat work-related injuries and illnesses in collaboration with other core OHS disciplines. Trainees in our clinical programs (MSN, DNP) benefit from clinical practice under the supervision of highly qualified faculty and clinical mentors in clinical settings that are well-suited to meet their OHN learning needs. For example, one of our clinical supervisors, Christine Pionk, MS, AGNP-BC is ABOHN-certified as a COHN-S and has decades of experience in managing a myriad of worker health and safety issues at Michigan Medicine. Trainees in the LAI program focus on leadership skills and will be able to leverage their leadership with their OHN training to be leaders in their future practice.

Trainees in clinical education programs (i.e., AGPCNP, PCFNP, LAI) also benefit from clinical rotations in a variety of OH clinical settings. For example, clinical experiences are available at both hospital-based occupational health clinics and community-based occupational health clinics. Additionally, through post-clinical conferences, students practicing at diverse locations share their experiences and learn vicariously from one another. In most years, selected students visit a rural village in Thailand, where they provide primary care and explore worker health and safety issues from a global perspective. However, in 2022-23, this 2-week rotation was suspended due to the pandemic.

Faculty. OHN students are served by 46 tenure track, 51 clinical track, 3 research professor track, and 3 research scientist track faculty. OHN Director Dr. McCullagh served as the primary coordinator for the OHN offerings, and during the reporting period she served as advisor for 9 MSN students and 7 DNP students, taught NURS 572 Issues in

OHN (2 credits) and served as guest faculty in undergraduate and graduate courses (e.g., NURS 456 Public Health Nursing, NURS 603 Advanced Health Assessment). Christopher Friese, PhD, RN, FAAN, Associate Director, and Elizabeth Tone Hosmer Professor of Nursing, tenured, participate in student recruitment, program development, and trainee evaluation. Dr. Friese's external funding from NIOSH, NINR, and other sources strengthened the environment for research training in the OHN program. Elizabeth Kuzma, DNP, FNP-C, (not ERC grant supported) is a Clinical Assistant Professor with extensive clinical experience as a Family Nurse Practitioner (FNP). She was responsible for assisting in student recruitment and advisement, program development, didactic instruction and clinical supervision of FNP-OHN and other students. She also assisted in the identification, assessment, and allocation of clinical sites to the Family Nurse Practitioner program, matching sites and preceptors to student interests and needs. Beth Duffy, DNP, RN, CPNP, FAAN, (not ERC grant supported) is a Clinical Associate Professor and Director of the DNP program. She was responsible for advising the DNP students and helps facilitate the clinical site experience of the DNP-OHN students. April Bigelow, PhD, AGNP-BC, (not ERC grant supported) is a Clinical Associate Professor, and assisted in student recruitment and advisement, program development, didactic instruction and clinical supervision of AGNP-OHN and other students. She also assisted in the identification, assessment, and allocation of clinical sites to the Adult-Gerontology Primary Care Nurse Practitioner program, matching sites and preceptors to student interests and needs. Dr. Rosemberg assisted in hosting a UMSN-wide recruitment event, and also guest lectured in several courses (e.g., EHS 796- Psychosocial Factors Impacting Occupational Health & Safety at the UM School of Public Health; NSG575 Leadership for Population Health at the University Washington School of Nursing) on topics related to population health and occupational health and safety.

Appointments and honors.

Prof Marjorie McCullagh, PhD, RN, APHN-BC, COHN-S, FAAOHN, FAAN was awarded the American Public Health Association Public Health Nursing Section Ruth Freeman Award for a distinguished career in public health administration, education, policy, practice, and research. She was also: recognized by the American Nurses Credentialing Center with the Center's Certified Advanced Public Health Nurse Award; appointed by the University of-Michigan Board of Regents as Sally L. Lusk Collegiate Professor of Nursing (the collegiate professor is named for UMSN professor emerita, former COHSE OHN Director, and eminent scientist, Dr. Sally L. Lusk); inducted into the Sigma Theta Tau International Nursing Research Hall of Fame; and designated by the American Academy of Nursing as Edge Runner. Edge Runners are nurses who have designed innovative models of care or interventions which improve health, impact cost, and influence policy

Prof. Christopher Friese, Ph.D., RN, AOCN launched and serves as Director of UMSN Center for Improving Patient and Population Health. He also: was appointed to National Academy of Medicine study, Use of Elastomeric Respirators in Health Care; served as RWJ fellow in health policy (AY 16-17) in office of US Senator Bob Casey; was installed as the inaugural UMSN Elizabeth Tone Hosmer Professor of Nursing; was appointed by President Biden to the National Cancer Advisory Board, which advises the President, his cabinet, and federal officials on policies pertaining to cancer research (As a member of the Board, Friese will guiding the Director of the National Cancer Institute in setting the course for the national cancer research program); was appointed associate director for cancer control and population sciences at UM Rogel Cancer Center; published the results of his NIOSH-funded trial in *Oncology Nursing Forum* (The Oncology Nursing Society recently profiled Dr. Friese's research in their membership newsletter, as Friese and colleagues lead an interprofessional training program on chemotherapy safety for nurses and pharmacists, funded by the National Cancer Institute); was appointed by the US Comptroller General to the PCORI Governing Board (the Patient-centered Outcomes Research Institute is a government-sponsored organization charged with investigating the relative effectiveness of various medical treatments, and Medicare may consider the Institute's research in the determining what sorts of therapies it will cover).

Prof Marie-Anne Rosemberg, PhD, RN was appointed to the UM National Center for Institutional Diversity, Diversity Scholars Network. She was also appointed: as Vice Chair for Research for the Department of Systems, Populations and Leadership; to the NIOSH Service Sector Council; and as Associate Editor of Current Topics for *Workplace Health & Safety*

Research. OHN faculty continued to secure funding for their scholarship on worker health and safety. Dr. McCullagh was Principal Investigator on an NIH/NINR-T32 training program, Complexity: Innovations in Patient Care Using Team Science Dr. Rosemberg was Principal Investigator on a project funded by the BlueCross BlueShield Foundation of Michigan focusing on mental health and substance use among hotel workers. Dr. Rosemberg was also Co-Investigator on an NIH-funded R01 research project focusing on workplace vigilance and sleep health among Black workers. She is also Co-Investigator on an NIH administrative supplement on home care workers.

Research teams at the UM School of Nursing (UMSN) contribute to the achievement of NORA strategic goals in the form of published research reports, presentations, media interviews, and other products. Selected examples include (Centers for Disease Control and Prevention,2014):

- *Service Sector* ***Strategic Goal 5***: Reduce the incidence and severity of occupational injuries by 20% as measured in lost work days among hotel and motel workers (Prof. Rosemberg).
- *Agriculture Sector* ***Strategic Goal 5***: Improve the health and well-being of agricultural workers by reducing occupational causes or contributing factors to acute and chronic illness and disease (Prof. McCullagh).
- *Healthcare Sector* ***Strategic Goal 3***: Reduce or eliminate exposures and adverse health effects caused by hazardous drugs and other chemicals (Prof. Friese).

Publications and presentations. One OHN faculty member (McCullagh) was included as paid personnel. Prof. McCullaugh produced 23 peer-reviewed publications over the reporting period. Prof. Rosemberg produced 20 peer-reviewed publications over this period. Both faculty provided numerous presentations over this period at technical and professional meetings in domestic and international locations.

Outreach, service and continuing education. Dr. Rosemberg served as the Associate Editor for the Current Topics for the Workplace Health & Safety journal. In this role she reached out to occupational health and safety professionals, colleagues (e.g., other ERC OHN directors), students, and postdocs to submit worker-related manuscripts. As one of the board of directors, Dr. Rosemberg also conducted outreach and connects with individuals related to the UMSN OHN program during the AAOHN conference. Dr. Rosemberg served as an external advisory board member for the 1) University of Cincinnati Occupational Health Nursing (OHN) program and 2) The Center for Health, Work & Environment at the Colorado School of Public Health.
Promoted OHN education in undergraduate and graduate courses in other departments and other schools in the region. Dr. McCullagh, in cooperation with the AAOHN, continues to promote and disseminate a suite of teaching/learning resources (e.g., podcast, readings, lesson plan, examination items) for under-resourced baccalaureate public health nursing faculty, developed and tested in collaboration with a panel of OHN educators. Dr. Rosemberg was and to date continues to be a dissertation committee member for a NIOSH ERC funded PhD student (Paidamoyo Matibiri) at the University of Cincinnati OHN program. Dr. Rosemberg is the faculty of record for N580 (undergraduate population health course) and includes a lesson introducing students to occupational health nursing.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

- During the reporting period, the program enrolled Masters and DNP students. (No PhD students were enrolled.) In addition, students have the option of completing a variety of elective courses (residential, distance, and short-term).
- The Master of Science in Nursing (MSN) Program includes tracks for primary care nurse practitioners and OHN managers. In addition to completing studies in their respective tracks, trainees complete 15 hours of coursework in occupational health. Courses include introduction to occupational health, occupational

diseases, occupational ergonomics, issues in occupational health nursing, professional seminar, and responsible conduct of research and scholarship. Two- and three-year programs of study are offered.
    - The Primary Care Program provides graduates with advanced clinical skills to diagnose and treat work and non-work-related injuries and illnesses in collaboration with other core OHS disciplines. Trainees enroll in one of two tracks: PCFNP (74 credits) or AGPCNP (69 credits).
    - The Leadership, Analytics, and Informatics program prepares nurse leaders and managers.
- The Doctor of Nursing Practice (DNP) Program is intended for students who aim to practice OHN at the highest level and translate evidence to practice optimizing worker health outcomes and care. Trainees enroll as post-master's or post-BSN students. In addition to completing studies in their respective tracks (FNP at 89 credits, or AGNP at 85 credits), trainees complete 15 hours of coursework in occupational health for a total of 104 or 100 credits. Courses include introduction to occupational health, occupational diseases, occupational ergonomics, issues in occupational health nursing, professional seminar, and responsible conduct of research and scholarship. A four-year program of study is offered for post-baccalaureate students. OHN faculty serve as mentors for DNP students conducting their capstone projects.
- The PhD Program prepares skilled researchers and educators with specialization in OHN for leadership roles in academia and government. Trainees enroll as post-master's or post-BSN students. In addition to completing studies in theory development and research skills, trainees also complete 15 hours of coursework in occupational health (similar to above). A four-year program of study is offered for post-baccalaureate students.
- Promoting engagement in research. In addition to the OHN programs of study, the OHN faculty promotes engagement of trainees and others in OH research. Depending on their program of study and personal interests, students can select from a variety of research roles and projects in OH-related areas. Students not enrolled in the OHN programs also benefit from the presence of the program, as several nursing courses are infused with OH content. For example, Dr. McCullagh teaches a lesson in every section of NURS 503 Advanced Health Assessment that includes a clinical decision-making exercise focusing on taking an exposure history. This course is required of all advanced practice nurses (e.g., acute and primary care APRNs). OHN faculty also serve as guest lecturers in the undergraduate public health nursing course each semester, introducing students to occupational health nursing as a specialty practice. Faculty also participate with the ERC in offering continuing education (CE) programs.
- Other
    - OHN students and faculty attended the UM COHSE-sponsored Regional Education and Research Center Symposium. The theme was Meeting Challenges in Occupational and Environmental Justice. This provided opportunities for connections, dissemination (e.g., student posters), and interdisciplinary collaborations (e.g., during the occupational justice workshops).
    - Students and faculty are provided opportunities for industry/plant tours. A recent example was the Ford Rouge Factory Tour which took place during the April 2023 Regional Symposium.
    - In the winter/summer 2022, OHN students completed the NURS572 course on Issues in Occupational Health Nursing. As part of this course (during the COVID pandemic), students completed virtual tours of workplace sites and debriefed with faculty.
    - OHN students and faculty are encouraged to apply for COHSE PPRT research grant support. PhD nursing student Florence Johnson (not ERC funded) was successful in obtaining competitive PPRT funding to support her work on caregivers of dementia patients.

B.5. How did you disseminate the results to communities of interest?

Education Services. Dr. McCullagh maintained informative Web pages at the University, informing viewers about faculty occupational health activities.
Publications of program faculty and trainees. One OHN faculty member (McCullagh) was included as paid personnel. Prof. McCullaugh produced 23 peer-reviewed publications over the reporting period. Prof. Rosemberg produced 20

peer-reviewed publications over this period. Both faculty provided numerous presentations over this period at technical and professional meetings in domestic and international locations.

OHN faculty also provided consultation services to a variety of local, state and national groups including industry and associations.

- Dr. McCullagh served as a member of the University of Michigan Health System Nursing Health & Safety Committee, developing and maintaining programs to prevent healthcare work-related illnesses and injuries.
- Dr. McCullagh served as a University of Michigan MHealthy Wellness Champion, developing and promoting worker health programs for University employees, particularly those at the School of Nursing.
- Dr. McCullagh served as a Board member for the non-profit advocacy organization, Noise Free America, working to promote the establishment and enforcement of laws and regulations to control environmental noise.
- Dr. McCullagh critically reviewed occupational health-related manuscripts for publication in various scientific journals (e.g., Workplace Health and Safety, BMC Nursing, International Journal of Environmental Research and Public Health).
- Dr. McCullagh served as the liaison between the National Hearing Conservation Association and the American Association of Occupational Health Nurses.
- Dr. Rosemberg served as the Associate Editor for the Current Topics section for the *Workplace Health & Safety* journal, the primary occupational health nursing journal.
- Dr. Rosemberg chaired the 4th objective on chronic conditions for the NIOSH Healthy Work Design (HWD) Council.
- Dr. Rosemberg served as Elected Director for the Midwest Region, Board of Directors of the American Association of Occupational Health Nurses (AAOHN).
- Dr. Rosemberg served as a NIOSH research grant reviewer.
- Dr. Rosemberg served as an external advisory board member for the 1) University of Cincinnati Occupational Health Nursing (OHN) program and 2) The Center for Health, Work & Environment at the Colorado School of Public Health.

<u>Press, social media and other dissemination activities</u>

- Semiannual newsletters were sent to UMSN faculty, staff, and students about the OHN's milestones and associated members' endeavors.
- Dr. Rosemberg contributed to the development of the recently published guideline for temporary agencies and employers to protect temporary workers.
  - National Institute for Occupational Safety and Health, National Occupational Research Agenda Services Sector Council, American Society for Safety Professionals, American Staffing Association, Safety and Health Assessment and Research for Prevention Program [2022]. Protecting temporary workers: Best practices for host employers. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2022-126, https://doi.org/10.26616/NIOSHPUB2022126
  - OH faculty contribute to and provided a number of other dissemination activities, including webinars and public-facing blogs.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

- Increase enrollment in the OHN program, focusing on the recruitment of students from diverse backgrounds. We will work in collaboration with UMSN's recruitment team to use various in-person and virtual events targeting potential and currently enrolled UMSN students.
- Continue our efforts to engage and enroll PhD students in the OHN concentration.
- Continue to facilitate degree completion of currently enrolled MSN and DNP students.

- Continue to work with students to produce and disseminate scholarly posters and papers.
- Strengthen the social media presence of the OHN program to foster connections with a variety of constituencies.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
Cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
MARJORIE. MCCULLAGH	Y	MCCULLAGH, MARJORIE E	PHD,MSN,BSN,BS,MS	Director	0.0	1.8	0.3			

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: Rosemberg, Marie-Anne
c. Changes in Other Support:
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The Michigan OHN Program prepares advanced-level OHN specialists and leaders with expertise in professional practice, administration and management, and program development and evaluation. To meet this goal, program faculty recruit highly qualified students, engage in discovery to advance the OHN knowledge base, and perform service at local, regional, national, and international levels. The objectives to accomplish this mission are:

- Prepare a diverse pool of advanced-level OHN specialists and leaders with expertise in professional practice, administration and management, and program development and evaluation.
- Provide NP graduates with advanced clinical skills to diagnose and treat work-related injuries and illnesses in collaboration with other core OHS disciplines.
- Prepare skilled researchers and educators with specialization in OHN.
- Promote OHN education in undergraduate and graduate courses in other departments and other schools in the region.
- Participate with the ERC in offering high-quality Continuing Education (CE) programs.
- Maintain a high level of interdisciplinary interactions between and among ERC students and faculty.

In achieving these objectives, the Michigan ERC OHN Program is enhancing academic and practitioner human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OHN academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards, as well as new OHN practitioners who can directly apply the knowledge and skills obtained from the Michigan ERC OHN program to promote and protect the health of American workers.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The public health relevance of this training grant is that we have trained multiple students in the field of occupational health nursing, and their research and career trajectories has contributed to the overall goal of improving occupational safety and health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures
N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents
N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
N/A

G.2 Responsible Conduct of Research

Format. The training program in RCR includes learning in a variety of formats: classroom, online instruction, seminar, and mentoring. Faculty participation, duration, and frequency of these formats is described below.

We require formal instruction in RCR for all OHN students, appropriate to their program level. Students can select didactic courses from the School of Nursing or the Department of Environmental Health Sciences (EHS) in partial fulfillment of training requirements. OHN students may enroll in either of two RCR courses: EHS 510 or NURS 803. EHS 510 is coordinated and taught by Center Deputy Director Prof. Batterman; NURS 803 Responsible Conduct of Research and Scholarship is taught by Dr. Erin Kahle, and includes student completion of the UM online course, *Program for the Education and Evaluation of Responsible Research and Scholarship* (PEERRS). Both courses (EHS510 and NURS803) include all NIH required areas (i.e., conflict of interest, human subjects, safe laboratory practices, mentor/mentee responsibilities and relationships, collaborative research, peer review, data management; misconduct, authorship, social responsibility, ethical issues, environmental and societal impacts, rigor and reproducibility).

- DNP and PhD students. Students complete NURS 803.
- MSN students. Students may select EHS 510 RCR or NURS 803.

This approach, together with other courses, helps prepare students for careers as advanced practice nurses, and provides them with a foundation for understanding and implementing scientific findings to support evidence-based practice. The training available through the School of Nursing is described in detail below.

The face-to-face classroom RCR course (NURS 803) was temporarily moved to an online format in response to CDC pandemic guidelines; as of fall, 2022, face-to-face instruction has resumed.

Subject matter/content. The following RCR topical areas are included in the training program via NURS 803

1. Misconduct in Academic Research and Scholarship: Fraud, Fabrication, and Plagiarism
2. Intellectual Property: Data Storage and Ownership
3. Responsible Authorship and Publications
4. Human Subjects Research and IRBs
5. Animal Use and Care: Laboratory Safety and Responsibilities
6. Mentor/Mentee Relationships
7. Conflict of Interest: Personal, Professional, and Financial
8. Foundations of Research & Scholarship in Society and in the Global Workplace
9. Research Administration
10. Export Controls

Faculty Participation. Regardless of topic area or mode of instruction, PhD-prepared faculty with research experience design, lead, and evaluate all student learning experiences. Faculty lead student learning experiences in the classroom and online, serve as role models in RCR, and mentor students in their individual research (or capstone) projects.

Duration of Instruction. Trainees are engaged in structured learning activities in RCR throughout the entire traineeship period for a minimum of 36 hours, not inclusive of individualize learning experiences with their mentors.

Frequency of Instruction. At the DNP and PhD level, trainees receive instruction in RCR during every semester of their traineeship. Student participation and success in RCR instruction is ongoing, with monitoring of knowledge (e.g., tests in short and for-credit courses), oral mastery of content (e.g., seminars), and demonstrated skill performance (e.g., mentored sessions). Master's-level students complete a more limited training program is more focused on the structured RCR course.

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?
N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?
N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?
N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276

UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

OHN Program graduates and students have contributed to the enhancement of OHN services in the US and abroad since program inception in 1985. The OHN Program has had high impact on worker health and safety, including strengthening the OHS workforce and profession. Since 2018, we have graduated 20 specially trained (MSN, DNP) OHNs who have gone on to promote the health of workers in hospital based OH clinics, public and private industry, and clinics providing services to businesses.

The program recruits a diverse community of students, faculty and staff from a wide range of personal and academic backgrounds and works carefully and collaboratively to make sure each individual experiences equitable opportunities and a sense of full belonging. Program graduates promote the health of workers by preventing injury and illness and promoting safe and healthful behavior, performing numerous and diverse roles, including management, assessment, direct care, prevention, and research. Our research training program has made notable contributions, and our research productivity is demonstrated by the many publications and presentations by our faculty, students, and graduates. OHN Program faculty are engaged in high-quality and rigorous funded research that addresses the needs of vulnerable worker populations, including (a) under-researched populations, such as farming, construction, and technology; (b) vulnerable and underserved workers at high risk for injury and illness, such as farmers, low-income

service workers (often immigrants); and (c) serious adverse effects of worksite and environmental conditions, e.g., noise, chemical exposure.

A. COVER PAGE: OCCUPATIONAL SAFETY ENGINEERING

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2022-06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **OSE Program Director:** LEIA STIRLING, BS MS PHD Phone Number: 734-764-6473 Email: leias@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The mission of the OSE Program is to be an internationally-recognized center of excellence for research and graduate education in the design, analysis, implementation, and improvement of facilities, equipment, tools, and processes to assure the safety and well-being of human resources in all work environments and the surrounding communities. Our research and educational programs utilize principles of ergonomics and engineering to prevent: (1) "acute" injuries, property damage and/or environmental damage caused by overt events associated with human error or hardware failure, and (2) "overuse" musculoskeletal injuries caused by chronic exposures during physical work. Embedded within these efforts are also elements of Diversity, Equity, and Inclusion (DEI). University of Michigan's College of Engineering has a strategic vision that is based upon "People-first Engineering." Considerations of safety engineering and ergonomics are aligned with a people-first framework that supports workers through intentional research and design.

An overriding goal is to produce graduates who will have a high impact on improving workplace health and safety through research and professional practice.

The major goals for the OSE academic training program include:

- Providing a high-quality educational experience for all students through continuous improvement of our curriculum and courses. Program graduates will have the necessary training to work as a member of a multidisciplinary OHS team, and specific technical skills in safety engineering and ergonomics.
- Expanding educational opportunities to include new technologies for supporting total worker health, including topics around wearable technologies.
- Increasing the number and types of interdisciplinary learning opportunities.
- Increasing the number of interactions between our students and working OHS professionals.
- Increasing the number of students in our Masters and PhD programs, with emphasis on recruiting U.S. citizens, Permanent Residents and underrepresented minorities.

Educational activities to support this mission include:

- ***Research training*** (PhD in Industrial and Operations Engineering, Mechanical Engineering, Robotics, or Biomedical Engineering). The PhD degree is for students who wish to pursue careers in academic, government, and industrial research settings. Following extensive coursework, students conduct their dissertation research in either a laboratory or field setting.
- ***Professional training*** (MS/MSE in Industrial and Operations Engineering). The Masters degree is for students who wish to pursue careers as full-time safety and ergonomics engineers, managers, or consultants. Students complete a curriculum that covers technical and managerial topics, learn basic research methods, and perform an independent research or professional project.
- ***Continuing Education.*** Short courses are provided for occupational health professionals, managers, engineers, and labor representatives who desire specialized training in safety and ergonomics.
- ***Elective courses for students in other disciplines.*** Courses in safety and ergonomics are taken for elective credit by undergraduate and graduate students from a variety of ERC and non-ERC academic programs in the College of Engineering and other academic units.

B.2. What did you accomplish under these goals?

Enrollment and Recruiting Update

Of the 25 current students, 5 are receiving full or partial NIOSH support as a trainee for the current academic year (AY22-23). We are proud of the diversity of our students, although are working through the pathways to continue to increase the URM representation.

Program Graduates

Over the reporting period, the OSE program graduated 16 students, including 5 Masters students and 11 PhD students. We currently have 3 Masters students and 22 PhD students in the program. Of the 16 graduates, 4 (25%) received either full or partial NIOSH support as a trainee. Of the 16 graduated students, 6 (36%) were female and 1 (6%) was an URM. Of the current 25 students, 11 (44%) are female and 3 (12%) are URM.

During this current funding cycle, we placed four NIOSH trainees in faculty positions (Dr. Heejin Jong is an Assistant Professor at Arizona State University; Dr. Sol Lim is an Assistant Professor at Virginia Tech; Dr. Yadrianna Acosta-Sojo is an Assistant Professor at Auburn University; and Dr. Na Du is an Assistant Professor at University of Pittsburgh).

Faculty and Curriculum Updates

The OSE program is fortunate to have a large and highly productive team of faculty and staff. Faculty, staff members, and adjuncts have taught OSE courses and advised/supported student research over the past year. This teaching continues to contribute across domains, including industrial hygiene, epidemiology, construction safety, systems reliability, and management.

OSE Director Prof. Stirling, who joined the OSE program in Fall 2019, developed and introduced in Fall 2020 a new course titled Quantifying Human Motion Through Wearable Sensors. This is an elective course for undergraduate and graduate students to learn how to use wearable motion sensors to estimate body posture, joint angles, and stride parameters, as well as using these measures to define metrics relevant to assessing musculoskeletal injury risk factors. This course is currently being taught in 2022 and will become a formal numbered course next time it is taught.

Prof. Stirling developed and taught a new course called Exoskeleton Human Factors, which was a section of Engineering 100. The introductory engineering class, Engineering 100 is taken by all freshmen and transfer students. Dr. Stirling created a new section that is aligned with workplace safety and ergonomics from the perspective of new assistive technologies. This early exposure supports students engagement in IOE and creates an additional pathway for the graduate program.

Prof. Stirling and Mr. Joe Montgomery (Technical Communications) co-developed and taught a new course called Intro to Human-Robot Interaction that is a required course for all students in the newly formed Robotics Department. The course covers key topics, including but not limited to socially engaged design, human cognitive processes, human-machine communication, sizing and fit, automation, and technical communication.

Dr. Paul Green, Dr. Bernard Martin, and Prof. Stirling developed material for a new elective for undergraduate and graduate students that focusses on ergonomics labs. The course includes measurements related to lighting, sound, response time, anthropometry, biomechanics, fatigue, and attention. The course also includes instruction in technical reports and survey design. The course is anticipated to be taught next academic year.

Dr. Oshin Tyagi was hired and will join the faculty in Fall 2023. She brings expertise in occupational biomechanics, brain imaging, and neuroergonomics. Additionally, Prof. Clive D'Souza left University of Michigan July 2021; Dr. Julia Diebol and Dr. Brad Joseph joined as instructors for the OSE program in 2018; and Dr. Barry Kantowitz and Dr. Alfred Franzblau discontinued direct participation in the ERC activities, as they are now retired.

Faculty and Student Accomplishments

Our faculty and students received a number significant awards during the reporting period. For example, the UM Human Factors and Ergonomics Society (HFES) Student Chapter was awarded the *Outstanding Student Chapter Gold*

Award. Our faculty and trainees also received a number of awards (e.g., Dr. Matt Reed received the Kenneth M. Reese 2022 Outstanding Research Scientist Award, U-M College of Engineering; trainee Jacqueline Hannan, received the prestigious NSF Graduate Research Fellowship; OSE Director Prof. Stirling was selected as a 2021 American Institute of Aeronautics and Astronautics (AIAA) Associate Fellow; Prof. Nadine Sarter was elected to the National Academy of Engineering (NAE); trainee Na Du received the HFE WOMAN Rising Star Award, HFES Student Member with Honors Award, and HFES Aging Technical Group Scholarship; and Dr. Jessie Yang received a National Science Foundation (NSF) CAREER Award).

Several of our faculty serve as Associate Editors of the following archival journals: IEEE Transactions on Human Machine Systems (Liu), Occupational Rehabilitation (Armstrong), Human Factors (Armstrong and Sarter), Movement Science and Sport section of Frontiers in Psychology (Martin), Traffic Injury Prevention and International Journal of the Digital Human (Reed). Faculty also serve on the editorial boards and as ad hoc reviewers for major occupational health and safety journals, as peer reviewers for NIH, NIOSH, and NSF research proposals, and as members of NRC advisory committees.

Faculty research

OSE faculty were successful in obtaining research grants and contracts from federal, state, and private sector sponsors (e.g., the National Science Foundation, U.S. Department of Transportation, CDC-NIOSH, U.S. Dept. of Education, Michigan Department of Licensing and Regulatory Affairs, Toyota Research Institute, and others). Much of this funding was used to our Masters and PhD students as Graduate Student Research Assistants.

Research-to-practice activities/accomplishments

Example of r2p during the reporting period include:

- Dr. Leia Stirling and Dr. Jessie Yang's Boeing received contracts that support translating technologies such as exoskeletons and autonomous vehicles to support workers.
- Dr. Matt Reed translated University research on seated postures to design tools and specifications for civilian and military vehicles.
- Dr. Matt Reed translated 3D anthropometry tools and techniques for product and apparel design applications.
- Dr. Paul Green authored several SAE, ISO, and ANSI standards and developed educational materials on those standards. He serves on the Executive Council of the Human Factors and Ergonomics Society and leads the HFES Implementation of Standards Task Force.
- Dr. Leia Stirling led the development of an ASTM F48 standard that is currently in review to support the evaluation of exoskeletons during environment transitions (e.g., between level ground, stairs, and ramps).
- Dr. Nadine Sarter's work on increasing complexity on modern flight decks supported the Federal Aviation Administration (FAA) in developing regulatory and certification guidance for advanced flight deck automation. With the FAA, her contributions support safety and risk mitigation through implications for crew complements and automation/autonomy levels in commercial transport operations. She also translates flight crew visual scanning techniques on transport category aircraft to inform flight deck automation.
- Dr. Nadine Sarter helped NASA develop and evaluate paths to Urban Air Mobility (UAM) which assume various levels of vehicle autonomy and thus different roles for onboard and ground-based operators. This work will contribute to safe operations of aerial vehicles in major metropolitan areas.
- Dr. Paul Green translated research findings to develop and lead a Human Factors Engineering Short Course that brings attendees from industry (about 70 attendees each year) as well as a specialized Boeing Human Factors Engineering Short Course (2 4-day offerings).

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

The OSE program offers the following graduate-level courses within IOE:

- IOE 430 – Global Cultural Systems Engineering
- IOE 432 – Industrial Engineering Instrumentation Methods
- IOE 434 – Human Error and Complex System Failures
- IOE 436 – Human Factors in Computer Systems
- IOE 437 – Automotive Human Factors
- IOE 438 – Occupational Safety Management
- IOE 463 – Measure & Design of Work
- IOE 491 (Stirling) – Quantifying Human Motion Through Wearable Sensors
- IOE 491 (Yang) – User Experience Design
- IOE 533 – Human Factors in Engineering Systems
- IOE 534 – Biomechanics
- IOE 536 – Cognitive Ergonomics
- IOE 537 – Ergonomics for Inclusive Design
- IOE 539 – Occupational Safety Ergonomics
- IOE 635 - Laboratory in Biomechanics and Physiology of Work
- IOE 836 – Seminar in Human Performance
- IOE 837/EHS 668 – Seminar in Occupational Health and Safety Engineering

Depending on their specific research/professional interests, students take additional/ complementary coursework in other departments/institutes on campus which fosters interdisciplinary interactions and collaborations. In fact, six of the seven courses in the core OSE curriculum are taken with students from other ERC cores. For example, IOE 539, our core course in *Safety Engineering Methods*, includes a systems safety term project performed by an interdisciplinary team. Teams are organized with at least one student from each ERC discipline. In IOE 837/EHS 668 *Professional Seminar in Occupational Health and Safety Engineering*, OSE students collaborate with students from all ERC academic programs on team activities, and to evaluate guest speakers from academia and industry who cover the full spectrum of OHS disciplines. Students can also work on a one-on-one basis with a particular faculty member by completing a Directed Research/ Professional Project (IOE 590).

Training and professional development is fostered also by OSE faculty and students attending professional conferences, such as the Human Factors and Ergonomics Society (HFES) Annual Meeting (including the ErgoX Symposium) and the HFES International Symposium on Human Factors and Ergonomics in Health Care. Additionally, most IOE Ergonomics students are members of the University of Michigan HFES Student Chapter which received the 2022 Outstanding Student Chapter Gold Award from the national body of HFES. The Chapter supports student travel to ergonomics conferences and organizes visits to industrial sites, such as the Fermi nuclear power plant near Detroit, MI.

In 2022, The Industrial and Operations Engineering Department launched the Industry Partnerships Program, which supports communication channels between the department and industry, enabling direct sponsorship of projects, as well as supporting external internships and job placement. This program is especially relevant for the

IOE 590, which is the course that enables individual or group study, design or laboratory research in a field of interest to the student or group. Topics may be chosen from any area of industrial and operations engineering and are aligned with the OSE program for these trainees.

B.5. How did you disseminate the results to communities of interest?

During the project period, OSE program faculty prepared and/or published over 225 peer-reviewed journal publications and reports, with students as primary authors or co-authors on 110 of these. The results of the faculty's research and service work were also presented at major national conferences which resulted in additional proceedings papers and presentations. OSE faculty were also involved in various Continuing Education and Outreach efforts, as described in those sections of this final report.

OSE researchers also share their expertise and information about specific projects with professional organizations. For example, faculty members contributed to the development of standards developed by ASTM, SAE, ISO, and ANSI standards committees. OSE faculty have also helped companies like Siemens, Ford, GM, and FCA with the implementation of motion prediction algorithms into the Jack ergonomic software tool which is a widely used digital human model for industrial ergonomics analysis. Faculty members and their research groups also gave presentations to various organizations/societies.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

To support education not only in the classroom but in our research laboratories as well, OSE faculty will continue to seek research funding in the areas of physical ergonomics, cognitive ergonomics and safety from federal organizations, industry and foundations. This research will allow students to interact with practitioners and other ergonomics professionals.

Within the IOE department, the Associate Chair of Graduate Studies, the Director of Graduate Admissions, and the Academic Program Officer support recruiting activities and further improve our student guidance and advising activities. Updated brochures as well as platform and poster presentations by OSE faculty and graduate students at national and international meetings as well as other universities will assist with these efforts. We will also continue to host laboratory tours for high school students from southeast Michigan, including underrepresented students from Detroit. During these tours, career opportunities in occupational safety and ergonomics will be discussed. We reengaged this past year with summer camps and we will continue to engage this year in programs such as Discover Engineering and the Women in Science and Engineering (WISE) summer programs led through the University of Michigan College of Engineering.

We will again participate in the "Michigan Engineering Graduate Symposium", an open-house event where potential MS and PhD students are invited to campus to meet current graduate students and learn about opportunities for graduate education. We engage in the UM College of Engineering EMERGE (Explore Michigan Engineering Research and Graduate Education) program, supporting introducing students to the graduate program, with activities to support the application process and prepare for graduate school. We also plan to present in Engineering 110 Design Your Engineering Experience, a course that helps undergraduate students identify their own interests and goals, and discover the broader opportunities available through academic minors and co-curricular opportunities that align with their passions.

By participating in recruiting activities at the annual conferences of the Society of Hispanic Professional Engineers (SHPE) and the National Society of Black Engineers (NSBE), we hope to increase the number of underrepresented minority (URM) students who enroll in and graduate from our program. Financial support for these students is supplemented with fellowships provided by the university-wide Rackham Engineering Fellowship (REF) initiative. REF students receive three years of full financial support (tuition and stipend) from the university. This is matched by assistantships or traineeships for two additional years, providing financial assistance for a total of five years.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
LEIAS1	Y	Leia Stirling	BS,MS,PHD	Co-Investigator	0.0	0.7	0.5			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel:
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The mission of the OSE Program is to be an internationally-recognized center of excellence for research and graduate education in the design, analysis, implementation, and improvement of facilities, equipment, tools, and processes to assure the safety and well-being of human resources in all work environments and the surrounding communities. Our research and educational programs utilize principles of ergonomics and engineering with the objectives to prevent:

- "acute" injuries, property damage and/or environmental damage caused by overt events associated with human error or hardware failure, and
- "overuse" musculoskeletal injuries caused by chronic exposures during physical work.

In achieving these objectives, the Michigan ERC OSE Program is enhancing academic and practitioner human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OSE academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards, as well as new OSE practitioners who can directly apply the knowledge and skills obtained from the Michigan ERC OSE program to promote and protect the health of American workers.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The public health relevance of this training grant is that we have trained multiple students in the field of occupational safety engineering, and their research and career trajectories has contributed to the overall goal of improving occupational safety and health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research

The College of Engineering has implemented a Responsible Conduct of Research and Scholarship (RCRS) training requirements for all NSF/NIH-supported Masters and Doctoral students, including NIOSH trainees. These students must complete four 2-hour RCRS workshops taught by College of Engineering faculty, which cover 1) authorship, publication practices, and avoiding plagiarism; 2) data management and avoiding research misconduct; 3) responsibilities of collaborative research and avoiding conflicts of interest; 4) professional ethics and the environmental and societal impacts of engineering. In addition, the student participates in two hours of individual or group discussions facilitated by his/her mentor or researcher group director on RCRS topics. This course is run through our Program for Education and Evaluation in Responsible Research and Scholarship (PEERRS). The IOE Department requires that that students complete all four workshops during the first semester in the program.

In addition to these college-required RCRs training activities, all PhD and many Masters students in OSE perform research on human subjects at some point during their graduate education. These students must complete and pass an on-line training module prior to developing their research protocol and applying for approval from the Institutional Review Board (IRB). The course on *Human Subject Research Protections* deals with regulatory and ethical underpinnings of the policies that guide Institutional Review Boards (IRBs) and its policies and procedures, including why human research is regulated, with emphasis on the regulatory and ethical responsibilities of the Principal Investigator, IRBs, and university. Certification tests are embedded and must be satisfactorily completed before progressing.

All students engaged in research involving human subjects are required to submit their proposals to one of the UM *Institutional Review Boards* (IRB) for review and approval. Students work with faculty mentors to develop research protocols, write informed consent documents, prepare IRB applications, and then collect human subjects data. Trainees often play a significant role in completing the IRB application in conjunction with the research projects required for their degree. Through the one-on-one mentoring environment, trainees can hone the knowledge and skills required to perform safe and ethical research.

All faculty are required to pass PEERRS tests before mentoring NIOSH trainees, and all students supported by ERC funds are required to pass the relevant PEERRS certification tests prior to engaging in research.

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?

N/A

G.4.b Inclusion Enrollment Data

N/A

G.4.c ClinicalTrials.gov

N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?

N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

This award supports the education of graduate students in the area of occupational safety engineering and ergonomics. These students receive coursework and mentored research training that broadens the student ability to obtain employment in a role to assess worker health and safety, as well as design and evaluate new methods to reduce risks. The award also supports elective training for students that are not specializing in occupational safety engineering and ergonomics, but who would like to gain additional expertise to broaden their knowledge and capability.

A. COVER PAGE: CONTINUING EDUCATION

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **CE Program Director:** SHERYL ULIN, BS, MS, PHD Phone Number: 734-763-0133 Email: sherylul@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The Michigan ERC has a long history of providing continuing education opportunities to practicing professionals and has been in continual operation since the mid-1980s. The primary goal of the Continuing Education (CE) Program is to provide current occupational health and safety information to those who can affect workplace health and safety. Our specific aims include:

- Conducting at least two CE programs in three of the disciplines associated with the Michigan ERC annually;
- Having strong involvement of Michigan ERC faculty in our programs;
- Conducting at least 15 programs annually; and
- Training a minimum of 600 people annually.

B.2. What did you accomplish under these goals?

Throughout the 5 years of this project the goals were exceed annually. The pandemic required the Continuing Education program to switch to only virtual programs. The virtual formats developed continue to be used because of their success. FY 2023 included both in-person and virtual courses.

2022-2023:
Between July 2022 and June 2023 we conducted 17 continuing education programs and eight webinars (through 4/27/2023 with 2 additional webinars occurring by 6/30/2023). As of 5/25/2023, a total of 2,302 people attended a course or webinar resulting in 23,502.8 person-hours of training. This does not include the number of people attending Dr. Neitzel's Coursera-based MOOC series (over 6500 additional learners) or the number of people utilizing our YouTube Channel, C4E TV, that contains Tutorials on using the ergonomics software, 3DSSPP, as well as ergonomic case studies. Course reviews continue to be extremely positive. A May 2023 attendee of the course, Ergonomics Principles for Workstation Assessment and Design, wrote, "I think it was one of the best I have ever attended in 40 years". Enrollment for our virtual nursing courses continues to be larger than the pre-pandemic in-person offerings.

2021-2022:
Between July 2021 and January 2022, we conducted 11 continuing education programs and nine webinars, attended by 2,082 people, resulting in 18,571 person hours of training. These programs, coupled with the planned programs for the remainder of the year (through June 30, 2022), will bring us to 15 programs for the year, meeting our annual goal of 15 programs during the COVID-19 pandemic. Additionally, nine webinars were conducted through January 2022 and eight additional webinars are planned later during the current fiscal year. The table following lists the courses already offered.

As in past years, we continue to have strong participation by our ERC faculty as planners, directors and lecturers in our programs. Collectively, our faculty members have high academic credentials and are nationally and internationally recognized for work performed in a broad range of expertise. The School of Public Health, the College of Engineering and the School of Nursing that are the home academic departments for these individuals and they have consistently been ranked among the best in their fields. In addition, these strong and respected ERC faculty members allow us to identify, attract and utilize complementary national and international experts in our programs, expanding our ability to cover a broad range of topics.

2020-2021:
Between July 2020 and January 2021, we conducted 10 continuing education programs and nine webinars, attended by 1,382 people, resulting in 17,152 person hours of training. These programs, coupled with the planned programs for the remainder of the year (through June 30, 2021), will bring us to 15 programs for the year, meeting our annual goal of 15 programs during the COVID-19 pandemic. Additionally, nine webinars were conducted through January 2021

and eight additional webinars are planned later during the current fiscal year. The table following lists the courses already offered.

2019-2020:
Between July 2019 and January 2020, we conducted 9 continuing education programs and 13 webinars, attended by 2,957 people, resulting in 15,894 person hours of training. These programs, coupled with the planned programs for the remainder of the year (through June 30, 2020), will bring us to 18 programs for the year, surpassing our annual goal of 15 programs. Additionally, 13 webinars were conducted through January 2020 and five additional webinars are planned later during the current fiscal year. The table following lists the courses already offered.

2018-2019:
Between July 2018 and January 2019, we conducted nine continuing education programs and nine webinars, attended by 1,630 people, resulting in 15,311 person hours of training. These programs, coupled with the planned programs for the remainder of the year (through June 30, 2019), will bring us to 18 programs for the year, surpassing our annual goal of 15 programs. Additionally, nine webinars have been conducted through January 2019 and ten additional webinars are planned later during the current fiscal year. The table following lists the courses already offered.

Program statistics by core disciplines, 7/1/2018 – 6/30/2023
(Excluding data from webinars conducted in May and June 2023)

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	40	1525	28,463.05
Occupational Safety & Ergonomics	45	10324	30,263
Occupational Health Nursing	67	4469	22,137.85
Other	13	2757	47,229.55
Total	165	19,075	128,093.45

Program statistics by core disciplines, 7/1/2022 – 6/30/2023
(Excluding data from webinars conducted in May and June 2023)

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	8	307	6163
Occupational Safety & Ergonomics	5	175	3670
Occupational Health Nursing	10	1370	4949.75
Other	2	450	8720
Total	25	2302	23,502.75

CE Course Chart

Program statistics by core disciplines, 7/1/2021 – 6/30/2022

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	8	229	4835
Occupational Safety & Ergonomics	15	2238	5724
Occupational Health Nursing	10	926	8283
Other	4	1080	14499.75
Total	37	4473	33341.75

CE Course Chart

Program statistics by core disciplines, 7/1/2020 – 6/30/2021

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	10	417	2883
Occupational Safety & Ergonomics	14	1701	3859.75
Occupational Health Nursing	8	1362	6839
Other	4	739	10954
Total	36	4219	24535.75

CE Course Chart

Program statistics by core disciplines, 7/1/2019 – 6/30/2020

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	8	319	8147.8
Occupational Safety & Ergonomics	15	2709	3656
Occupational Health Nursing	11	1351	4837
Other	1	265	6387
Total	35	4644	23027.8

CE Course Chart

Program statistics by core disciplines, 7/1/2018 – 6/30/2019

Core Discipline	Number Courses Offered	Number Attendees	Person-Hours of Training
Industrial Hygiene	6	253	6434.25
Occupational Safety & Ergonomics	13	2306	3948.35
Occupational Health Nursing	11	655	6634
Other	2	223	6668.8
Total	32	3437	23685.4

Several programs deserve special mention.

- The Comprehensive Industrial Hygiene Review course has been offered twice annually for many years and again received excellent attendee reviews this past year. This is a testament to the quality of our presenters, resulting in the best form of advertising: attendee recommendations to prospective registrants. The course is now being offered virtually in two-hour segments, two days per week for ten weeks due to the pandemic. For this course, there are fourteen instructors who cover all rubrics associated with the Industrial Hygiene Certification exam. The lectures are recorded and available for one year after the conclusion of the course.
- Two Human Factors Engineering Short Courses are offered in successive weeks annually. Participants can attend one or both courses. These programs are nationally and internationally known and recognized by human factors professionals. The courses conducted in July 2021 were the 61st year they were offered. Attendance is very strong and the speakers, topics, materials, and small group exercises are updated annually. These programs focus on designing products, systems and services to make them easier, safer and more effective for human use. Dr. Paul Green, University of Michigan faculty member and Course Director, is a strong leader for these courses. The courses were offered virtually and in a synchronous manner during July 2021. The Federal Aviation Administration sent many employees to this course in 2021.
- Dr. Christopher Friese from the School of Nursing recently developed the Multi-Professional Oncology Safety and Simulation Training for nurses and pharmacists. Chemotherapy safety is taught using interprofessional case studies and discussion groups during this course. Funding from the National Cancer Institute and the National Institute of Health assisted with the development of this program. This course was conducted virtually due to the COVID-19 pandemic.
- The two-day course, Ergonomic Principles for Workplace Assessment and Design, was re-designed and conducted virtually with on-demand recorded presentations and synchronous discussion sessions (This course spanned FY 2021 and 2022. The attendance data was reported for FY 2021.). During the discussion sessions, instructors answered questions, facilitated case studies and provided supplementary material. During this course, speakers from the University of Michigan and industry provide attendees with tools for assessing workplaces and developing interventions to reduce worker exposure to the risk factors of musculoskeletal disorders. Work-related musculoskeletal disorders account for 34% of workplaces injuries and illnesses in the United States. Consequently, there is great interest in this program. This virtual course had higher enrollment. The course was offered in-person during FY 2023. Attendee course evaluations were excellent.
- The two-day workshop, Using the 3D Static Strength Prediction Program™ (3DSSPP™), was conducted twice in October 2021 for UAW-Ford. This 2-day program focuses on teaching safety professionals and ergonomists how to use a computer-based tool to analyze and design manual materials handling jobs within worker safety and performance limits. Each attendee has their own computer so they are able to utilize the software with

input from instructors. Numerous workplace examples are used so attendees learn how to input worker and workplace data into the program and correctly interpret the results.

- The Professional Development Course, Analysis of Manual Work Tasks and Application of Localized Fatigue TLV®, was conducted by Dr. Tom Armstrong at AIHCe in May 2023. This course was well attended by in-person and virtual conference attendees. Attendees learned how to use the ACGIH TLV® for Localize Fatigue to evaluate work force patterns and 1) determine if jobs may be excessively fatiguing and 2) identify engineering or administrative controls for controlling fatigue.
- The three-day course, Physical Assessment for the Occupational Health Nurse and 2-day course, Updates in Occupational Health Nursing, were redesigned and conducted virtually with on-demand recorded presentations and synchronous discussion sessions. During the discussion sessions, the instructor answered questions, facilitated case studies and provided supplementary material. This virtual course had higher enrollment including local attendees as well as international registrants. The virtual course format was particularly attractive to nurses who have difficulty being away from their work site even though they enjoy in-person courses.
- The 2nd annual Workplace Mental Health Conference was provided virtually in conjunction with the University of Michigan Depression Center. This half-day synchronous program brought together mental health experts and workplace safety and health professionals to discuss the use of initiatives to improve mental health in the workplace.
- We continue to co-sponsor webinars with the Applied Ergonomics Conference, the American Association of Occupational Health Nurses and all of the ERCs.
- ERC funds were used to support eight webinars co-sponsored with AAOHN so that there would not be a charge to participate in the webinars. Webinar attendance is considerably higher when there is not a charge to participate. After the "live" date of the event, the webinar is available free (on-demand) for AAOHN members as part of the AAOHN Online Academy.

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

All of the courses, webinars, and YouTube tutorials provide professional development opportunities for a wide variety of health and safety professionals and others who interact with these professionals.

B.5. How did you disseminate the results to communities of interest?

In addition to the open enrollment courses and webinars, YouTube videos were also developed to provide free content to many people.

2022-2023:

YouTube video tutorials were used as both a method of disseminating continuing education content and as outreach since people who do not regularly attend occupational health and safety courses and webinars are interested in watching short YouTube videos about occupational health and safety topics. YouTube Analytics for C4ETV from 7/1/2022 – 6/05/2023 include:

- 60,624 minutes watched (1010.4 hours)
- 33,250 views

2021-2022:

YouTube video tutorials were used as both a method of disseminating continuing education content and as outreach since people who do not regularly attend occupational health and safety courses and webinars are interested in watching short YouTube videos about occupational health and safety topics. YouTube Analytics for C4ETV from 7/1/2021 – 1/19/2022 include:

- 40,752 minutes watched (679.2 hours)
- 21,138 views

2020-2021:
YouTube video tutorials were used as both a method of disseminating continuing education content and as outreach since people who do not regularly attend occupational health and safety courses and webinars are interested in watching short YouTube videos about occupational health and safety topics. YouTube Analytics for C4ETV from 7/1/2020 – 1/31/2021 include:

- 30,972 minutes watched
- 16,500 views

2019-2020:
YouTube video tutorials were used as both a method of disseminating continuing education content and as Outreach since people who do not regularly attend occupational health and safety courses and webinars are interested in watching short YouTube videos about occupational health and safety topics. YouTube Analytics for C4ETV from 7/1/2019 – 1/31/2020 include:

- •38,148 minutes watched
- •19,988 views

2018-2019:
YouTube video tutorials were used as both a method of disseminating continuing education content and as Outreach since people who do not regularly attend occupational health and safety courses and webinars are interested in watching short YouTube videos about occupational health and safety topics. YouTube Analytics for C4ETV from 7/1/2018 – 1/31/2019 include:

- •14,100 minutes watched
- •7,500 views

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

In the upcoming year, our plan remains essentially the same as presented in the competitive renewal proposal. We plan to: offer at least 15 programs addressing the four core disciplines represented by our ERC (Industrial Hygiene, Occupational Safety Engineering, Occupational Health Nursing, and Epidemiology); train at least 600 people; and involve the support of at least 10 UM ERC faculty and staff in the planning or execution of our programs. We will co-sponsor programs where possible and appropriate to leverage our NIOSH support. We will assess needs via multiple mechanisms, including surveys and contact with advisors from the core disciplines. We will conduct a survey of past attendees to assess the impact the programs are having on the attendees' occupational health and safety knowledge and practice. Specific new initiatives for the upcoming fiscal year include investigating new program offerings and continued development of short YouTube video tutorials on various occupational safety and health topics. Currently, C4E TV, a YouTube channel, contains more than 140 ergonomic case studies and 17 tutorials on using the 3DSSPP™ software. Additional YouTube tutorials exploring industrial hygiene topics have also been developed.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
Audio or Video
-YouTube videos available on the ERC website

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
SHERYLUL	Y	Sheryl Sue Ulin	BS,MS, PHD	Co-Investigator	5.5	0.0	0.0			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: No
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The overall goal of the Continuing Education (CE) Program at the University of Michigan Education and Research Center (ERC) *is to provide current occupational health and safety (OHS) information to those who can affect workplace health and safety with the ultimate goal of reducing injuries and illnesses in the workplace*. Our programs provide information and activities designed to build skill and knowledge in practicing OSH professionals and others that have a strong stake in protecting and enhancing inclusive workplaces, and the health, safety, and well-being of workers. The programs include examples of diverse workers, address issues for under-served populations, and the ergonomics and nursing courses specifically address workplace assessments and accommodations to provide inclusive workplaces and experiences. Our audience includes occupational health physicians and nurses, industrial hygienists, safety personnel, engineers, managers, human resource professionals, supervisory personnel, workers, labor representatives, and various occupational-health-care-related professionals. Businesses and industries represented by this audience are broad and include automotive manufacturing, service providers, healthcare, pharmaceuticals, energy producers, consulting and many others. We aim to provide *as many high-quality, innovative programs* in as many subject areas as our financial and intellectual resources will permit. We strive to provide programs that are needed and that will stimulate enrollment. In addition, we provide webinars and short *YouTube* videos. We strive to integrate the concepts of diversity, equity, and inclusion into all of our offerings, both in terms of topical content, as well as in course marketing and delivery. All of these actions help develop human resources by educating OHS professionals and providing them with cutting-edge tools and knowledge.

E.2 - What is the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The Michigan ERC utilizes a centralized CE Program that serves all core academic areas within the ERC: Industrial Hygiene (IH), Occupational Health Nursing (OHN), Occupational Safety Engineering (OSE), and Occupational and Environmental Epidemiology (OEE). The Michigan ERC has a long history of providing continuing education opportunities to practicing professionals, and it has been in continual operation since the mid-1980s. The primary goal of the CE Program is to provide current OHS information to those who can affect workplace health and safety, and in doing so to provide professionals with new information related to the practice of OHS, the implementation of novel prevention and intervention techniques, and the application of new technologies to enhance public health.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

Nothing to Report

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research
N/A

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

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3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component

N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets.

Note: project outcome information will be made public in NIH RePORTER

Overall, the CE Program record of course offerings in the reporting period shows remarkable stability, depth and breath, innovation, and impact. Our innovation and flexibility during the COVID-19 pandemic allowed us to continue to provide training to OHS professionals. Because several virtual courses were provided “on-demand”, course enrollment increased. Specifically, occupational health nurses were the front-line health gatekeepers for many companies. The flexibility of on-line courses allowed them to obtain training without having to travel or hire others to cover their clinics. This allows a significant increase in the numbers of individuals reached. The virtual formats we are using, course instructors and content receive very good attendee reviews.

A set of materials is produced for each CE program we offer. These materials are ERC-published and distributed to program attendees. While these materials may not meet the definition of publications addressed by the Center’s Core academic disciplines, they represent enduring resource materials developed by program faculty for the future reference of program attendees and others. For our virtual programs, we also provide digital files of these materials and supplemental resources and tools. Copyright to these materials remains with each presenter, not the ERC.

A. COVER PAGE: OUTREACH

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **OUTR Program Director:** SHERYL ULIN, BS, MS, PHD Phone Number: 734-763-0133 Email: sherylul@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The primary goals for the Outreach Program include:

- Increase awareness of occupational health and safety and the related professions by providing occupational health and safety information to individuals and organizations;
- Advance curriculum and research related to occupational health and safety at other universities and in other departments and centers within our university by providing curriculum, lectures, consultations, and other support;
- Interact with professional and scientific organizations and other agencies to identify and solve occupational health and safety problems;
- Assist business, industry, other organizations, and practitioners in reducing workplace injuries and illnesses; and to
- Introduce students (elementary – high school) to occupational health, safety and ergonomics.

B.2. What did you accomplish under these goals?

We address the Outreach Program objectives in multiple ways. The first involves activities conducted by UM faculty and staff on an individual basis, which requires minimal NIOSH funding. Our very active faculty and staff engage in many outreach activities: they assist institutions, universities, government, and other organizations to develop occupational health and safety programs and training materials; provide presentations and lectures; respond to inquiries from many groups and communities, including the media, to promote occupational health and safety; and consult with organizations and industry to identify and/or solve OH&S problems. In addition, tours are provided on the University of Michigan campus and elsewhere that introduce elementary, middle school, and high school college students to safety and health issues and concepts. We have not been able to provide tours during the COVID-19 pandemic.

The second method focuses on larger-scale projects with funding support external to the ERC. ERC faculty and staff often have the primary responsibility for conducting these projects. Center faculty are engaged in many outreach and educational activities, as shown by the following examples of activities and projects in the reporting period.

- The State of Michigan *Consultation, Education and Training* (CET) grant aids small Michigan businesses to address ergonomics issues (Continuing Education and Outreach Director Ulin). This project has been on-going for 28 years and has provided training to over 6,400 people and over 8,700 hours of technical assistance to Michigan companies, engaging OSE faculty and staff. A YouTube channel, C4E TV, contains more than 150 ergonomic case studies that originated from this grant.
- Ergonomic software for job analysis and design was developed, enhanced, and distributed (retired OSE Prof. Woolley). Seventeen YouTube tutorials were developed under the guidance of retired OSE Prof. Woolley and Continuing Education and Outreach Director Ulin. In October 2020, HumanTech/VelocityEHS licensed the software, Three-Dimensional Static Strength Prediction Program™, and is now the software distributor. This is the most widely used biomechanics software nationally and internationally.
- ERC Center Director Batterman is engaged with the Detroit and southeast Michigan community through his role on several task forces with the State of Michigan Department of Environment, Great Lakes and Energy,

his service to the *Urban Research Center* and several non-governmental organizations, and his assistance and partnering with the Detroit Health Department. He also serves as the public health representative on the Michigan Drinking Water Commission, which is concerned with outreach, education and action to remedy risks associated with lead pipes.

- Center Director Batterman leads the *Exposure Assessment* Core of the NIEHS- supported P30 Core Center in Environmental Health, which was refunded in the project period. He also provides extensive assistance to the P30's Community Outreach and Education Core which produced videos and fact sheets in collaboration with community members from Detroit and elsewhere.
- The *Fogarty International Center for the Global Environmental and Occupational Health (GEOHealth) Program*, which is directed by OE Prof. Robins, functions to promote occupational and environmental infrastructure in Southern Africa through pilot research funding in OH&S and mentoring of doctoral students in Ghana, Nigeria, Benin, and Cameroon. A centerpiece of the research concerns occupational health issues at a large e-waste recycling in Ghana. We continued to assist four doctoral students from Ghana (all graduating in this or the prior project period) and one former OE student (Zoe Lazarus).
- ERC faculty and staff serve as consultants for labor and standards organizations, government agencies and employers (P. Green, J. Meeker, B. Martin, M. McCullagh, R. Neitzel, C. Friese, N. Sarter, L. Stirling and M. Reed).
- ERC faculty serve on various boards for national professional organizations and standards development organizations. For example, IH Prof. Neitzel provides extensive service to the *American Industrial Hygiene Association* and was elected Vice-Chair of the *ACGIH TLV Physical Agents Committee,* and OHN Prof. McCullagh served as a Board member for the non-profit advocacy organization, *Noise Free America*, working to promote the establishment and enforcement of laws and regulations to control environmental noise. In addition, Prof. McCullagh served as liaison between the *National Hearing Conservation Association* and the *American Association of Occupational Health Nurses*, member of the University of Michigan Health System *Nursing Health & Safety Committee*, and served as a University of Michigan *MHealthy Wellness Champion*, promoting worker health programs to University employees.
- ERC faculty and staff provide a brief introduction to occupational health, safety and ergonomics to students (grades 4- 12). Activity based learning tools were developed by Dr. Stirling, Dr. Yang and their students. Dr. Ulin assists with program logistics, lesson development and program evaluation.

<u>Highlights of recent Outreach activities include:</u>

- <u>OSE Prof. Green</u> continues to be a member of SAE standards committee and has developed *YouTube* videos on Human Factors Standards. Additionally, he developed presentations and workshops on automated vehicle take over and safe driver interfaces. He is also an At-Large Executive Council Member for the Human Factors and Ergonomics Society.
- <u>OSE Prof. Armstrong</u> provided job design and ergonomics consulting services to various volunteer organizations. In 2017, 77.34 million adults (30.3 percent) volunteered through an organization (2018 Volunteering in America report). A newly funded NSF project will examine connectivity and future of remote work.
- <u>OSE Prof. Yang</u> provided four invited presentations on trust dynamics in human autonomy teaming. She also provided an invited presentation for an IEEE conference workshop on Shared Autonomy in Physical Human-Robot Interaction: Adaptability and Trust. In addition, she developed a new undergraduate / graduate course, User Experience Design (IOE 491), that emphasizes human-centered design. Dr. Yang received a NSF CAREER award and additional outreach activities will be coordinated through that award.
- <u>OSE Prof. Stirling</u> founded and participates in a monthly telecon with a group of women faculty to discuss research and career interests. Their research topics include biomechanics, robots, space health and injury prevention. In addition, she mentors postdocs, graduate students and undergraduate students in her research team and is the faculty advisor for the UM CLAWS (Collaborative Lab for Advancing Work in Space) student team.
- <u>OSE Postdoctoral Fellow, Yadrianna Acosta-Sojo</u> wrote an article for the Applied Ergonomics Society newsletter that described her recent exoskeleton publication in layman's language. The article was well

received. Dr. Acosta-Sojo was mentored by OSE Prof. Stirling during her Postdoctoral Fellowship and she joined faculty at Auburn University in January 2022.

- OSE Professor Emeritus Chaffin provided a presentation for the "Titans of HFES Symposium" sponsored by the Human Factors and Ergonomics Society. This virtual symposium showcased some of the premier researchers, practitioners, and academicians in HFES.
- OSE Researcher and CE / Outreach Director Ulin co-chairs the Applied Ergonomics Conference Marketing committee and is a member of the conference organizing committee. Additionally, she assists the Applied Ergonomics Society newsletter editor by soliciting new content and writing articles for the monthly on-line publication that is written for ergonomics practitioners. Additionally, she worked with UAW Health and Safety staff to provide access to workplace videos and documentation so they could utilize this information in upcoming training initiatives. Dr. Ulin is also working with a group of national experts to develop ergonomics recommendations to be used during a mass fatality. Finally, she is scheduled to provide a presentation for an upcoming Forging Industry Association Conference.
- The University of Michigan Human Factors and Engineering Society Student Chapter exhibited annually at FestiFall and Winterfest to spread awareness about human factors and ergonomics to University of Michigan students. In addition, the group hosted weekly Coffee Chats with INFORMS. The goal of the Coffee Chats is to engage students within IOE and create a supportive interdisciplinary network within the department, especially to those new on campus. Finally, the group will host a Biomechanics dinner in March 2022 that is open to the public from various departments and institutions so others can learn about OSE and network with student group members.
- IH Prof. Neitzel provided several online presentations for various professional organizations and academic institutions. Through the Intergovernmental Personnel Act (IPA Dr. Neitzel was a temporary NIOSH assignee (15% FTE) focused on promoting occupational health during the COVID-19 pandemic. He is working with the American Conference of Governmental Industrial Hygiene to develop an online certificate in Occupational Noise and Hearing Loss Prevention and is working with the University of Michigan Office of Academic Innovation to develop a MOOC series on Environmental Health Sciences, which will include a strong focus on occupational health. Prof. Neitzel is the Chair of the ACGIH Physical Agent committee. Dr. Neitzel's Apple Noise Study is frequently featured during University of Michigan televised sporting events to showcase the theoretical and applied research being conducted by Michigan faculty. Finally, Dr. Neitzel received the Michael Beall Threadgill Leadership and Service Award from the National Hearing Conservation Association in recognition of his research and service efforts to improve occupational hearing conservation.
- IH Professor Aurora Le provided several presentations to various groups including the UAW and several regional health and safety organizations. Dr. Le developed five infographics for the organization, Construction Research and Training (CPWR), based on the FAQ's about COVID-19 vaccines to make it more digestible and easier to understand for construction workers. She also provided interviews and written publications on "Sustaining a Healthy Nail Salon Workforce". Lastly, Dr. Le published a podcast on COVID-19, Aerosols, and Ventilation (https://sph.umich.edu/podcast/coronavirus/covid-19-aerosols-and-ventilation.html)
- IH Professor Emeritus Zellers is a member of the ACGIH Board of Directors and helps coordinate and teach in the IH continuing education courses.
- OHN Prof. McCullagh served as liaison between the National Hearing Conservation Association and the American Association of Occupational Health Nurses. In addition, she serves as a Board member for the non-profit advocacy organization, Noise Free America and is a MHealthy Wellness Champion at the University of Michigan, developing and promoting worker health programs for University employees. Dr. McCullagh also provided interviews to members of the press regarding hearing health.
- OHN Prof. Friese led a NCI-funded grant to deliver chemotherapy safety education to oncology nurses and pharmacists. Additionally, he was appointed to a six-year term on the Patient-Centered Outcomes Research Institute (PCORI) Board of Governors and is an elected member of the National Academy of Medicine. He was appointed to the National Cancer Advisory Board, which advises the President, his cabinet, and federal officials on policies pertaining to cancer research. Dr. Friese collaborated with University of Michigan Center of Academic Innovation and the College of Pharmacy to create the Under the Skin teaching tool. The tool is described here: https://news.umich.edu/new- learning-tool-click-a-button-and-dive-under-the-skin-of-

chemotherapy-patients/. Lastly, Dr. Friese provided written and oral communications about How Nurses Coping With the Covid Crisis? Including an interview on the Daily Show (https://www.youtube.com/watch?v=tjICmQc647w&t=1387s)

- OHN Prof. Rosemberg is a member of the National Occupational Research Agenda (NORA) Services Sector Council for CDC/NIOSH and the UM National Center for Institutional Diversity, Diversity Scholars Network. Dr. Rosemberg partnered with Dr. Le to write an article about the Ergonomic Challenges in Nail Salons for the Applied Ergonomics Society Ergo Connections Newsletter.
- MIOSHA Alliance increases the advertising and hence the impact of COHSE outreach activities.
- Doctoral students in COHSE and the Department in Environmental Health Sciences organized an all-day symposium on Feb. 18, 2022 entitled *Current Perspectives in Environmental Justice and How We Can Play a Role in Advocacy.* This event included four outstanding external speakers, a poster session, a coffee chat, and other activities, which was open to the entire campus community and beyond.

The third method involved direct NIOSH outreach funding. The Center engages in various activities, including the following:

- Webcasts: UM occupational health and safety seminars were recorded for webcast. These seminars are available for viewing on the Michigan ERC website by practicing professionals and students at no charge.
- Conference exhibits: NIOSH funding was utilized to exhibit at regional and national health and safety conferences. We are planning exhibits at the Applied Ergonomics Conference, American Industrial Hygiene Conference and Exposition and the Michigan Safety Conference during this fiscal year.
- Website: NIOSH support was also important for maintaining communication channels with practicing professionals via our ERC website and monthly email announcements.

These communication channels were used extensively to advertise our ERC programs.
The ERC website is continually revised and improved.

- Social Media: Twitter, Facebook, Instagram and LinkedIn are regularly used to publicize ERC events, research, and highlight accomplishments.
- Co-sponsorship of conferences: The Center provided co-sponsorship of one national ergonomics conference and the regional Michigan Industrial Ventilation Conference.
- Tours: Tours of the Center for Ergonomics research labs were provided to elementary, middle school and high school students as well as industry visitors. We also previously provided tours of manufacturing facilities and a waste water treatment center to foster integration among the various disciplines represented by the COHSE students.
- Flyers and fact sheets: We developed and distributed flyers regarding the Center and fact sheets (e.g., "Why study occupational health?").
- Regional collaboration: The Midwest ERC Directors (Illinois, Ohio, Kentucky, and Michigan) are meeting monthly or bimonthly via Zoom to share ideas and resources when possible. In addition, the ERCs are cross-advertising programs and opportunities.

A new consortium involving the ERCs at Michigan and Cincinnati and the Occupational Medicine Program at Michigan State University, called the Michigan-Ohio Occupational Research Education Program (MOORE), has been formed and awarded a R25 training grant to develop occupational health and safety materials and research experiences, to be shared among these partners and others. This work is kicking off in the reporting period.

- To determine and track the effectiveness of these outreach activities, Center staff track and review website hits and the use of social media. Google Analytics are one of the tools available for this purpose.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?

The Outreach Program provided considerable training and professional development for occupational health and safety professionals as well as community members, students (elementary school students through university students). Examples of projects that provided in- depth training and professional development include:

- The State of Michigan Consultation, Education and Training (CET) grant,
- Coffee chats as an informal way for faculty and students to meet in a casual setting,
- The Fogarty International Center for the Global Environmental and Occupational Health grant,
- YouTube videos featuring ergonomic case studies; and
- Offerings in ventilation systems and ergonomics training.

B.5. How did you disseminate the results to communities of interest?

Outreach activities are an integral part of the ERC and its philosophy, with direct significance for the reduction of workplace injuries and illnesses. ERC faculty and staff regularly participate in these activities and are preferred providers of these services. A variety of methods have been used and will continue to be used to disseminate information to communities of interest. These methods include seminars, radio interviews, webinars, YouTube videos, community meetings, and consultations with local, business, academic (local, national, and international) and political leaders.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

Outreach objectives are largely unchanged for the upcoming year and activities planned are like those noted above. Individual outreach activities will continue. We will continue work on outreach projects funded by non-ERC sources. We will capture new seminars for electronic distribution. We will be directly involved in the CET project to reach regional, small Michigan businesses. We plan to maintain and enhance the ERC website, and will continue monthly email announcements. The monthly email notes include upcoming courses, conferences, webinars, research applications and other information of interest to health and safety professionals. Additional marketing email notes are sent as necessary to promote continuing education and other opportunities. We will participate in regional and national health and safety conferences. We plan to continue to enhance and expand the website, and to continue tours of OH&S sites of interest. We also plan to build an interface for the YouTube channel, C4E TV, so users can easily find pertinent information.

Through our regional collaboration with ERCs in Ohio, Illinois, and Kentucky, we are planning a series of joint annual research-oriented symposia. The next symposium is tentatively planned for Spring 2024. Because four ERCs are advertising and participating in this symposia, greater visibility, participation, and impact are expected.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
SHERYLUL	Y	Sheryl Sue Ulin	BS,MS, PHD	Co-Investigator	5.5	0.0	0.0			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: No
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?
N/A

E.2 - What is the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

ERC faculty representing all core disciplines have promoted OHS topics and assisted other (non-occupational health and safety) departments at the University of Michigan by supplying lectures, providing advice, and mentoring students. Michigan ERC faculty and staff from all core disciplines delivered literally hundreds of presentations, lectures and demonstrations on a wide variety of OHS topics. Recipients included universities, labor organizations, trade and professional associations, government agencies, private employers, and high school and university students contemplating safety and health careers. Many organizations received consultation from Michigan ERC faculty and staff from all ERC disciplines. In addition to these efforts, the Michigan ERC supports small business consultations, provides web-based resources, and works with community partners and organizations to promote OHS. Collectively, these activities lead to a public and workforce that are more aware of, and better educated on, important OHS topics.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

Nothing to Report

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
N/A

G.2 Responsible Conduct of Research
N/A

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov

N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

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3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR.

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The major outcome of the Michigan ERC Outreach program include increased awareness – among both the public and the workforce – of established and emerging OSH hazards, and how these hazards can be mitigated or eliminated in order to promote public health.

A. COVER PAGE: TARGETED RESEARCH TRAINING

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **TRT Program Director:** STUART BATTERMAN, BS, MS, PHD Phone Number: 734-763-2417 Email: stuartb@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

Targeted Research Training (TRT) in OSH is comprised of a predoctoral scholars program that has the overall objective of promoting interdisciplinary training of doctoral students conducting NORA-related research. The specific goals of the TRT Program in the prior grant period were to:

- Recruit highly qualified doctoral students to the field of occupational health and safety;
- Impart to them through didactic instruction a working understanding of the academic and professional components of occupational health;
- Engage them in technical research that brings state-of-the-art methods and techniques to bear on cutting edge problems in areas related to the National Occupational Research Agenda (NORA);
- Make accessible the resources and faculty expertise available across the ERC;
- Engage them in ERC-sponsored activities so that they may contribute to, and benefit from, interdisciplinary interactions with participants from the ERC's core programs; and
- Facilitate their pursuit of careers in occupational health upon graduation.

Objectives of the TRT Program include providing financial support to highly qualified predoctoral students that increase the pool of highly trained researchers in the field of OH&S. Additional specific objectives are to impart through didactic instruction an understanding of the academic and professional components of occupational health; utilize laboratory rotations in OH&S; perform technical research that brings state-of-the-art methods and techniques to bear on cutting edge problems in areas related to the NORA; make accessible the resources and faculty expertise available across the ERC; engage them in ERC sponsored activities so that they may contribute to, and benefit from, interdisciplinary interactions with participants from the ERC's core programs; and facilitate the pursuit of careers in occupational health upon graduation. Finally, we will continue PEC efforts regarding Communications and Evaluation Plans to promote the TRT program.

B.2. What did you accomplish under these goals?

The major activities of the TRT Scholars Program included: (a) Active recruitment of candidates to the field of OH&S and student support; (b) Development of nomination packages for candidates; (c) Executive Committee review of nomination packages, scoring, selection, and communication to potential faculty mentors; (d) Communication to nominees; (e) Follow-up and planning for the next cycle; (f) Coordination and delivery of research training to TRT Scholars; (g) Tracking of Scholars; (h) Program evaluation.

Student support. The program typically provided partial support of one or two Ph.D. students each year; funding limitations enable full-time support of a single student. Students supported in the project period are listed below. (Academic year in parenthesis).

- Mislael Valentín-Cortés (2020-2023) was enrolled as a PhD student under the mentorship of OE faculty members Dr. Alexis Handal and Dr. Marie O'Neill in September 2020. He earned a B.A. in English from the University of Puerto Rico-Mayagüez and an MSW in Social Policy & Evaluation and a MPH in Health Behavior & Health Education from the University of Michigan. His research experience has focused on health equity and environmental justice, particularly examining the health impacts of climate change, occupational and environmental hazards, extreme events, and social inequities. For the past year, he has been an important contributor to research on the Michigan Farmworker Project (MFP) with Drs. Alexis Handal and OE Program Director Marie O'Neill where he has led qualitative data analysis procedures on occupational and environmental stressors faced by farmworkers under their supervision. He works with Dr. O'neill in the PRINCESA project, an epidemiologic birth cohort study that assesses the impact of air pollution, extreme heat, and other environmental hazards on birth outcomes in Mexico City. Mislael is also actively engaged in

research examining the effect of disasters, extreme weather events, and social inequities in Puerto Rico and he recently gave a B.2 (B.2 TRT.pdf) RPPR Page 216 presentation on his research entitled "Behavioral and Mental Health impacts of Hurricane Maria in Puerto Rico" at the American Public Health Association Annual Meeting. Support is anticipated to continue through Summer 2022, during which time Mislael will be undertaking coursework in Epidemiology in preparation for candidacy and will continue to work with Drs. Handal and O'Neill in the MFP and PRINCESA projects.

- Lauren Ward (2020-2023) was enrolled as a PhD student under the mentorship of IH faculty member Dr. Aurora Le in September 2020. She earned a BS in Biology from Purdue University and a Master of Public Health and Tropical Medicine at Tulane University. In Fall 2020, she participated in a research rotation with Dr. Le; during that time Lauren and Dr. Le participated in the University of Michigan's Rackham Faculty Committee on Mentoring (MORE) workshop. Lauren participated in two additional mentoring programs through the University of Michigan- as a mentor for the Undergraduate/Graduate Student mentorship program, and as a mentee for the Graduate Student/Alumni mentoring program. She completed three trainings with the New Orleans (NOLA) Ready Volunteer Corps and Medical Reserve Corps in preparation for future volunteering at COVID-19 vaccine sites. These trainings included Introduction to Vaccine Administration, Introduction to Sheltering, and Providing Culturally Competent Services at COVID-19 Vaccine Sites. Additionally, Lauren presented virtually at three conferences: International Society for Environmental Epidemiology (ISEE), American Public Health Association (APHA), and American Society of Tropical Medicine and Hygiene (ASTMH). In Winter 2021, she completed a research rotation with Dr. Richard Neitzel. Lauren created an IDP in September, 2020 which has been updated periodically. In the project period, she has been developing research ideas examining epigenomics/epigenetics effects in an occupational cohort with Dr. Jackie Goodrich, who is Research Assistant Professor in Environmental Health Sciences. In addition, she served as President of the UM Environmental Health Student Association. Lauren is expected to take her Doctoral Qualifying Exam in May 2022. ERC support is anticipated to continue through summer 2022.

- Kelly Broen (2019-20211) began her PhD studies under the mentorship of Dr. Jon Zelner in September 2019. She earned a BS in Human Health and Quantitative Sciences from Emory University and a Master of Public Health in Epidemiology from the University of Michigan School of Public Health in Winter 2019. Throughout fall 2019 and winter 2020, she completed her doctoral coursework, including training on interprofessional perspectives in occupational health and safety. In Summer 2020, she passed her comprehensive examination and progressed to candidacy. During fall 2020, Kelly conducted research with Dr. Zelner, and completed a first author manuscript on geomasking techniques for environmental and spatial public health data which was published in the International Journal of Health Geographics in January 2021 (doi: 10.1186/s12942-020-00256-8). She is also a co-author on a manuscript focused on understanding the potential socioeconomic and occupational drivers of racial disparities in COVID-19 mortality in Michigan which was published in Clinical Infectious Diseases in Fall 2020 (doi: 10.1093/cid/ciaa1723), as well as another preprint focused on the impact of observation bias on the quality of estimates made of infectious disease transmission rates in congregate settings such as hospitals, nursing homes, and other workplaces (doi: 10.1101/2020.11.02.20224832). In addition, Kelly also holds multiple leadership positions on campus, including as co-chair of the Epidemiology Doctoral Student Organization, Epidemiology dept. representative of Sexual and Gender Diversity in Public Health, and as a volunteer contact tracer assisting in the UM COVID-19 response. Kelly has formed her doctoral committee and plans to defend her prospectus in March 2021 and will add these specific goals and steps to her IDP during the summer 2021 semester. ERC support is anticipated to continue through summer 2021.

- Stephanie Sayler (2019) was enrolled as a PhD student under the mentorship of IH faculty member Dr. Richard Neitzel. She earned a BS in psychology at Armstrong State University (GA), a MS in Industrial Hygiene from the University of Michigan, and had substantial OHS experience in the Navy and elsewhere. For personal reasons, she withdrew from the program in January 2020.

Student recruitment and selection. The TRT Program recruited PhD students via the ERC's web site, advertising in each of the Center's academic program, and by directed emails. Program staff collected nomination packages which were reviewed by the Program leadership. Selection of trainees was accomplished with the input of the ERC Directors.

Evaluation and communications. As part of the Evaluation Plan, we conducted annual interviews with past trainees. As part of the Communications Plan, we developed short videos featuring students.

Course oversight. The Program provided oversight, support, conduct and revisions of didactic courses that constitute a portion of the trainees' academic program, including the following courses:

- EHS 668/IOE 837 Professional Seminar (interdisciplinary/interprofessional training).
- EHS 510 – Responsible Conduct of Research and Scholarship (meeting training requirements in this area.)
- EHS 850 – Research Design and Proposal Development in Environmental Health Sciences. This new course was offered in Winter 2022 by TRT Director Batterman with goals of training students to: (1) formulate and investigate a scientific question to address an occupational/environmental health issue; (2) develop a research proposal for effectively investigating a research hypothesis; (3) effectively critique reputable scientific literature to identify knowledge gaps; and (4) understand the grant review philosophy and process.

Interdisciplinary activities. The program ensured that trainees participated in interdisciplinary activities sponsored by the Center, including tours/plant visits, the ERC Regional OHS Research and Practice Symposium (last held on March 2021) and the annual EHS Research Symposia

B.3. Competitive Revisions/Administrative Supplements

N/A

B.4. What opportunities for training and professional development did the project provide?

Didactic training: Training opportunities include didactic courses that constitute a portion of the trainees' academic program. These focus on the following courses, noted earlier:

- EHS 668/IOE 837 Professional Seminar, which has been substantially revised as a hands-on course developing interprofessional education (IPE).
- EHS 510 – Responsible Conduct of Research and Scholarship was offered in two small sections in the fall 2021 semester. Several previously supported TRT Scholars also completed doctoral research under COHSE mentors.
- EHS 850 – Research Design and Proposal Development in Environmental Health Sciences. This new course was offered in Winter 2022 was described in Section B.2.

Interdisciplinary activities: The ERC sponsored or co-sponsored many activities that provide opportunities for professional development. Trainees are required to attend at least two of these opportunities. Selected opportunities include:

- Doctoral Day events, held virtually in January each year, this includes workshops and information programs (IH and OE Programs).
- Interdisciplinary Tours. We conducted virtual tours during the pandemic, and on-site plant/facility visits otherwise, typically two per year.
- ERC Regional Symposium: We conducted multi-ERC symposia in 2019 (in-person), 2021 (on-line), 2022 (on-line) and 2023 (in-person).
- The EHS Annual Symposium, organized by the EHS and EPID doctoral students (including IH and OE Programs) provides trainees with career development, organizational, and networking opportunities and experiences. These are typically held in February or March.

Mentoring. The TRT Program trainees are mentored by the program's experienced and accomplished faculty, including annual or more frequent meetings of program leadership with trainees to discuss progress and opportunities. We also require laboratory rotations of predoctoral trainees in at least two research groups. We also require completion and annual or biannual reviews of Individual Development Plans, most often using the interactive online Individual Development Plan (IDP) developed by FASEB and available through AAAS. Trainees are provided with examples of Individual Development Plans (IDPs) and are encouraged to develop IDPs that are reviewed at regular intervals (at least every 6 months) with their mentors. Predoctoral trainees submitted abbreviated IDPs with their annual progress reports, and the Program Director meets with all trainees, typically in January, to review progress. All trainees submit IDPs to the Program Director in April of each year. Using the IDP as a guide, the Program Director or Associate Director held annual discussions with each currently supported trainee regarding their progress toward career goals.

Other: The program also provided partial sponsorship for trainee participation in conferences and symposia of relevant professional organizations, including travel for networking and to present posters and papers.

B.5. How did you disseminate the results to communities of interest?

Trainees disseminate their scholarly results through

- Publications in journals
- Presentations to diverse audiences, including research symposia
- Consultations to industry, state or local trade associations, labor unions, hospitals, and other public groups.
- Other formats, including video and podcasts.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

We plan to continue with our plan to recruit highly qualified trainees to fill our predoctoral slots; provide professional development opportunities including review of each trainees IDP and progress; conduct the annual OHS research symposium; initiate additional interdisciplinary experiences and ensure attainment of the program goals by through program evaluations, oversight, and input from trainees, the ERC Directors, and our External Advisory Board.

No significant modifications are anticipated.

C. PRODUCTS

C.1. Publications, conference papers, and presentations
N/A

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS
STUARTB	Y	Stuart Batterman	BS,MS, PHD	Co-Investigator	0.0	2.1	1.1			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: No
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The goals of the Targeted Research Training Program at the University of Michigan Education and Research Center (ERC) are to:

- Recruit highly qualified doctoral students to the field of occupational health and safety;
- Impart to them through didactic instruction a working understanding of the academic and professional components of occupational health;
- Engage them in technical research that brings state-of-the-art methods and techniques to bear on cutting edge problems in areas related to the National Occupational Research Agenda (NORA);
- Make accessible the resources and faculty expertise available across the ERC;
- Engage them in ERC-sponsored activities so that they may contribute to, and benefit from, interdisciplinary interactions with participants from the ERC's core programs; and
- Facilitate their pursuit of careers in occupational health upon graduation.

In achieving these goals, the Michigan ERC is enhancing academic human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OHS academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The Michigan ERC TRT program serves trainees from all core academic areas within the ERC: Industrial Hygiene (IH), Occupational Health Nursing (OHN), Occupational Safety Engineering (OSE), and Occupational and Environmental Epidemiology (OEE). The TRT program has provided trainees with research training and experience that positions them to conduct cutting-edge OHS research, as well as to develop and disseminate new OHS knowledge, technologies, and practices.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

Nothing to Report

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements
N/A

G.2 Responsible Conduct of Research

All trainees complete mandatory training in the Responsible Conduct of Research that exceeds NIH requirement and also the University of Michigan requirements for individuals involved in research.

G.3 Mentor's Research Report or Sponsor Comments
N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
N/A

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The overarching goal of the Targeted Research Training (TRT) Program is to enhance the ERC's research training mission in an integrated fashion across the represented disciplines. The major activities of the TRT Program included: (a) Active recruitment of candidates to the field of OH&S with particular attention to goals of diversity, equity and inclusion; (b) Development of nomination packages for candidates; (c) Executive Committee review of nomination packages, scoring, selection, and communication to potential faculty mentors; (d) Communication to nominees; (e) Follow-up and planning for the next cycle; (f) Coordination and delivery of research training to TRT Scholars; (g) Tracking of Scholars; (h) Program evaluation.

Over the past project period, the program supported 7 doctoral students. In this and prior cycles, post-doctoral support was not part of the program. Our TRT Program graduates show strong progress commensurate with the trajectory expected for researchers and faculty. While recent graduates are still establishing their independence and research specialties, more senior graduates have done exceptionally well, based on our tracking of publications and other indicators.

A. COVER PAGE: PILOT PROJECT RESEARCH TRAINING

Project Title: OCCUPATIONAL SAFETY AND HEALTH EDUCATION AND RESEARCH CENTERS (T42)	
Grant Number: 5T42OH008455	**Project/Grant Period**: 07/01/2018 - 06/30/2023
Reporting Period: 07/01/2018 - 06/30/2023	**Date Submitted**: 10/30/2023
Program Director/ Principal Investigator RICHARD NEITZEL, BS MS PHD Phone Number: 734-763-2870 Email: rneitzel@umich.edu **PPRT Program Director:** ADAM FINKEL, AB,MPP SCD Phone Number: 202-406-0042 Email: adfinkel@umich.edu	**Administrative Official Information** ELIZABETH HOWARD 3003 S. State St Ann Arbor, MI 48109 Phone number: 734-764-7234 Email: howardel@umich.edu
Change of Contact PD/PI: No	
Human Subjects: No	**Vertebrate Animals:** No
hESC: No	**Inventions/Patents:** No

B. OVERALL ACCOMPLISHMENTS

B.1. What are the major goals of the project?

The Pilot Project Research Training Program (PPRTP) has as its the primary goal strengthening the occupational health and safety research capacity of the United States by increasing the number and quality of scientists who undertake research in occupational health and safety (OHS) disciplines and who are motivated to remain in the field as a career path. PPRTP also strives to advance timely, high-quality research to better assess and reduce chemical, physical, and other health and safety risks to workers. These goals are accomplished by enhancing opportunities for research training at the University of Michigan's Center for Occupational Health and Safety Engineering (UM-COHSE) and at other colleges and universities in HHS Region V (IN/IL/MI/MN/OH/WI).

The PPRTP provides short-term seed funds to support innovative pilot research projects in priority areas defined in the National Occupational Research Agenda (NORA). The program supports PhD students, postdoctoral fellows, and junior faculty at colleges and universities in HHS Region V (the Great Lakes Region) who wish to develop or enhance their OH&S research capabilities. The goal and objectives described above have not changed over the 42 years of COHSE's existence.

B.2. What did you accomplish under these goals?

Program Leadership

Dr. Adam Finkel assumed leadership of the PPRT Program in September of 2020. He is a Clinical Professor of Environmental Health Sciences at the University of Michigan School of Public Health and previously was involved with the UM ERC as a consultant to our Occupational Epidemiology Program, our Interdisciplinary Program, and as a PPRT application reviewer. He was also a founding member of the External Advisory Board of the Risk Sciences Center at UM-SPH for 10 years. He is a Clinical Professor of Environmental Health Sciences who focuses on quantitative risk assessment and cost-benefit analysis, and has contributed significantly over 35 years to science and policy about numerous occupational hazards, including chemicals (e.g., methylene chloride, diacetyl, 1-bromopropane, beryllium), musculoskeletal disorders, repetitive head trauma, respirator fit factors, and emerging risks from synthetic biology. Formerly, he was Director of Health Standards Programs at the U.S. Occupational Safety and Health Administration (OSHA), and Regional Administrator of OSHA for the Rocky Mountain region.

Proposal solicitation and selection

Program announcements are distributed several times each spring using our CE listserv, web site, direct contact with regional universities, targeted emails, other listservs, and posted advertisements (e.g., Board for Global EHS Credentialing). These announcements reach faculty and students in all ERC academic programs, NIOSH TPG Project Directors in HHS Region V, and other regional colleges and universities with OH&S research activities. The RFA is also posted on our website along with complete instructions and all application materials, which also shows abstracts and outcomes of previously funded projects.

The received proposals are distributed to members of the PPRT Program Scientific Review Committee (PPRP-SRC), evaluated using defined criteria, and a meeting is then held to discuss all applications and determine funding based on scores and the goal of a distribution of funded applications across disciplinary areas represented within COHSE.

The following persons served on the PPRP-SRC during the reporting period (2018-2023):

- Sheryl Ulin, Ph.D., Occupational Safety/Ergonomics and Outreach Programs

- Marjorie McCullagh, Ph.D., Occupational Health Nursing Program
- Stuart Batterman, Ph.D., Environmental Health Sciences Dept.
- Richard Neitzel, Ph.D., Industrial Hygiene, and Occupational Epidemiology Programs
- Edward Zellers, Ph.D., Industrial Hygiene Program (emeritus)
- Marie O'Neill, Ph.D., Occupational and Environmental Epidemiology Program
- Sung-Kyun Park, Sc.D., MPH, Occupational Epidemiology Program
- John Meeker, Sc.D., CIH, Occupational Epidemiology Program
- Leia Stirling, Occupational Safety Engineering Program
- Marie-Anne Rosemberg, Ph.D., RN, Occupational Health Nursing Program
- Thomas Armstrong, Ph.D., Industrial and Operations Engineering
- Clive D'Souza, Ph.D., Occupational Safety/Ergonomics Program (2018-2021)
- Hala Darwish, Ph.D., Occupational Health Nursing Program
- Sheria Robinson-Lane, School of Nursing
- Adam M. Finkel, Sc.D., CIH, PPRT Director

Additional reviewers from outside UM-SPH are often included when specialized expertise is helpful. For example, in the past 2 years we have benefited from reviews by:

- Jim Sayer, Ph.D., Director, UM Transportation Research Institute
- Linda Orta-Anes, Ph.D., Public Representative, United Auto Workers and University of
- Puerto Rico
- Robert Radwin, Ph.D., Dept. of Biomedical Engineering, Univ. of Madison-Wisconsin
- Alicia Koontz, Ph.D., Human Engineering Research Laboratories, Univ. of Pittsburgh
- Susan Silbey, Ph.D., Dept. of Anthropology, Mass. Institute of Technology
- Lisa Brosseau, Ph.D., Univ. of Minnesota (retired)
- Bill Perry, OSHA Director of Standards (retired)

At least two reviewers score each proposal, and Dr. Finkel serves as a third (or fourth) reviewer on every proposal. Reviewers also critique the reasonableness and adequacy of the budget; however, the budget is not considered in the quality score. For selected projects, the PPRTP Director may enter budget negotiations to ensure that funded projects meet program criteria and available funding. Copies of applications, along with evaluation scores and funding recommendations, are maintained by the Director and COHSE coordinator. Each funded project submits interim and final reports, and is to be completed within a year. We also require photos, vignettes, and other material for the website to promote the program and to disseminate program products. When a project is completed, a copy of the final report is maintained by the Program Director. The ERC Executive Committee and the ERC External Advisory Board review the program biannually.

<u>Current reviewed and funded studies</u>

In June 2022, we gave awards to four projects (of the five total proposals received), representing two universities in Region V (Wayne State University and The University of Michigan), as follows (the abstract from each proposal is included, along with brief information from each midyear report, received in February 2023).

Beginning in this cycle, and continuing forward, we provided accepted proposals with brief written feedback suggesting possible (as guidance only) improvements in methods, analysis, or dissemination (as before, we continue to provide feedback to proposals not accepted as to how they might improve a subsequent submission).

1. "**Gap pre-pulse inhibition of the acoustic startle reflex for tinnitus detection**." Trainee: Zakaria Enayati; Advisor: Prof. Avril Holt. School of Medicine, Wayne State University.

Noise is an occupational hazard that is often underestimated by workers. Noisy environments significantly contribute to hearing and balance related problems, such as hearing loss, tinnitus, hyperacusis, and falls. Subjective tinnitus affects approximately 15% of the United States population with similar prevalence in Europe, Asia, and Africa. This condition contributes to many mental health disorders and creates a financial burden for many experiencing this un-stoppable ringing. Unfortunately, there is not cure for tinnitus. There are no objective tests to detect tinnitus in humans. Thus, developing an objective, reliable test would substantially help with the diagnosis and treatment of tinnitus. In animal models of tinnitus, inhibition of the acoustic startle reflex has been used to detect tinnitus but this test remains controversial in pre-clinical and clinical studies. Therefore, the proposed studies have been designed to test and compare several parameters of the acoustic startle reflex in participants with and without tinnitus. The current study aims to assess the ability of normal -hearing controls and those with tinnitus to inhibit their acoustic startle reflex and determine the correlation of results with self-reported characteristics of tinnitus. We hypothesize that, in contrast to normal-hearing participants, tinnitus sufferers will demonstrate a reduced ability to inhibit their startle response. However, over time, those with tinnitus will maintain the same level of inhibition, while normal-hearing participants will demonstrate less inhibition.

2. "**Total Remote Worker Health: Developing a Remote Assessment Instrument of Physical, Emotional, and Musculoskeletal Health for Individuals who Work From Home**." Trainee: Jessica Francis; Advisor: Prof. Thomas Armstrong. College of Engineering, University of Michigan.

At this point in history, due to the COVID-19 Pandemic, many traditional work settings have now been replaced with new modalities - namely remote work and hybrid work (where individuals can split time between work from home and in person work). In a traditional in-person work modality, the worker is in a more controlled environment, worker behaviors can be observed, and worker tools can often be standardized (for example having the same office chairs for all workers). In a remote or hybrid work environment, the spatial and temporal relationships of the worker become less well-defined, and various aspects of home-life and work-life may start to blend together. Thus, it is important to understand the key benefits and challenges of remote work in relation to the overall health of remote and hybrid workers. Significance: Currently no tools or instruments focus on the total health of workers engaged in primarily remote work or hybrid work. We aim to introduce a tool that can quantify both mental and physical health through an instrument that can be self-administered remotely. Specific Aims: There are three key aims to our proposal 1) Develop a thematic understanding of key barriers and benefits of remote and hybrid work on the overall health of workers; 2) determine applicability and effectiveness of traditional ergonomic assessment tools for assessing remote and hybrid worker fatigue to prevent potential work-related musculoskeletal disorders (WMSDs); and 3) develop and deploy a pilot instrument that assess total remote and hybrid worker well-being and health. Broader Impact: This is a once-in-a-century chance to adopt a paradigm shift of work that can transformatively maximize benefits and minimize problems associated with remote work for both employers and workers. In this planning grant, therefore, we focus on remote work. The developed tool will help inform policy makers and employers of a worker's mental and physical well-being. In addition, This research will inform policies and recommendations for remote work in the future, as well as evolving hybrid models of work.

3. "**Use of Community-based Support Services Among Black Family Dementia Caregivers**." Trainee: Florence Johnson; Advisor: Prof. Sheria Robinson-Lane. School of Nursing, University of Michigan.

Dementia family caregivers are becoming an increasingly important part of the caregiver community, assisting with one or more activities of daily life, such as bathing, dressing, toileting, and feeding the person. They also assist with multiple instrumental activities of daily living, such as managing finances, which are common in caregiving. Caregivers provide physical and emotional support to people living with dementia, communicate and organize healthcare, other relatives, and healthcare providers, maintain safety at home and elsewhere, and manage health issues. According to the Alzheimer's Association, 48% of family caregivers care for someone living with Alzheimer's Disease and Related Dementias. Stress is widespread amongst family caregivers of persons with chronic health conditions. In particular, Black family caregivers of persons living with dementia, compared to their non-Hispanic White counterparts, spend some of the most prolonged caregiving hours and experience some of the highest stress levels. However, little is

known about the stress management strategies used by Black dementia family caregivers (B.F.C.) or the support they receive. It is unknown how much support B.F.C.s receive to manage psychological and physical stress. The proposed project aims to determine how community-based support services affect Black F.C.G.s' mental health and identify barriers and facilitators to caregivers' use of community-based support services. This mixed-method study will use a national dataset of older adults and their caregivers (N.H.A.T.S. and N.S.O.C.) to examine the relationships between Black dementia family caregiver stress, support services use, and health. Further, qualitative interviews with Black dementia family caregivers will examine caregiver experiences in obtaining training and support. Results will inform the development of future interventions that will improve care delivery and health outcomes for both F.C.G.s and persons with A.D.R.D.

4. "**Support for older workers with mobility limitations through indoor work environment interventions**." Trainee: Kamolnat Tabattanon; Advisor: Prof. Bernard Martin. College of Engineering, University of Michigan.

The population and proportion of older adults (age 65+ years) is increasing in the US. Alongside this trend, Americans are increasingly working into older age, with 20% of older adults either working or looking for work. To safely accommodate the projected rise in older workers, it is critical to account for the intersection of old age and mobility disability, as mobility disability incidence is increasing among aging adults. Manual wheelchair support for balance and mobility will be on the rise, though workers who transition to manual wheelchair use will be able to retain independence in movement and upper extremity tasks provided the environment-task demands are designed for inclusion. By addressing this subgroup of older adults with later-in-life incidence of disability, work environment evaluations can become more sustainably inclusive. Current work environments are lacking in this regard, as 22% of older adults with disabilities who ceased seeking work stopped due to discouragement, including from perceived discrimination for age and/or disability. Of further concern, recent studies suggest that disability populations are prone to underreporting their own difficulties when evaluating designs with traditional subjective measures. Yet the use of objective measures (e.g., biomechanics, task times) can be costly during design development. Better alignment between subjective ratings and objective performance can (1) result in designs that promote self-efficacy and remove psychosocial barriers; and (2) support future environment-task design processes towards broader inclusion. Therefore, we will investigate mobility performance between those with earlier-in-life (EL) and later-in-life (LL) incidence of manual wheelchair usage. Here, performance in an independent path following task is divided into assumed performance (how participants expect to perform), perceived performance (how participants think they performed), and effective performance (how objective measures quantify their completed performance). By comparing these categories, we will investigate internal representation of motor actions and test differences between groups. This will inform ways to support mobility through environmental indications as well as ways to supplement potentially biased subjective estimations in environmental evaluations. It is postulated that representation of the world as a function of assumed mobility impairment/deficiency is a factor in self-limiting mobility.

<u>Completion of studies in prior reporting periods</u>
In June 2021, we gave awards to five projects (of the seven total proposals received), representing two universities in Region V (Purdue and Michigan), listed below with a summary of the aims and accomplishments.

1. "**Design of a Computer-Vision Based System for Immediate Multi-Person Ergonomics Assessment in Veterinary Practice**." Trainee: Jing Yang; Advisor: Asst. Prof. Denny Yu. School of Industrial Engineering, Purdue University.

Compared with other occupations, veterinary medicine and animal care (VMAC) has the 2nd highest incidence rate for nonfatal occupational injuries and illnesses1. However, limited work has been done to understand and address the unique contributors to injuries in VMAC. Despite the availability of observer-based checklists and sensor-based techniques, they may not best approaches for ergonomic risk factors assessment due to their interference with workflow. To have an easy-to-use, accurate, and efficient ergonomic risk assessment in real-world operational environments, several research gaps need to be addressed; specifically, 1) non-intrusive techniques for continuous work ergonomics assessment and 2) intervention tools to engage current VMAC workers on the already-present injury

risk factors in the workplace. To fill the gap in this field, we propose a novel ergonomic risk management tool using computer vision that performs robust, constant, and automatic ergonomic assessment for multiple veterinary practitioners, either individually or collectively, under challenging acquisition conditions without the need for wearables. Two specific aims are proposed. Aim 1: a computer-vision based algorithm will be developed for real-time ergonomics assessment that overcomes current challenges of the VMAC environment: a) people in personal protective equipment (PPE), e.g., sterile scrubs and b) multi-person teams that frequently move throughout the procedure. The system predictions will be validated by statistically evaluating the agreement among proposed established methods like observer assessments by experienced ergonomists. Aim 2: a smartphone intervention will be developed following user-centered design protocol and prototyped. It will present the personalized ergonomic assessments captured by the computer vision algorithm (Aim 1) to engage workers in ergonomics and provide data-drive recommendations for improving user ergonomics. Iterative usability testing will be conducted with subject matter experts. Resulting prototype will be piloted through a comparative study where the ergonomic discomfort changes will be compared through pre- and post-experiment ergonomic discomfort questionnaire. The key deliverables of this work are to:1) improved veterinary practitioners' ergonomic awareness and preliminary evidence of our smartphone intervention impact on worker ergonomic risk exposure, 2) further the science of occupational health by providing a detailed understanding of unique exposures in veterinary medicines, and 3) the research from this work can lead to future translation by identifying needs and barriers for effective workplace interventions in VMAC.

Investigators obtained 10 video clips, from the campus animal hospital, of veterinary surgeons performing various tasks, and refined their algorithms to track various body parts through space and time.

2. "**Chlorinated Naphthalenes in Human Plasma: Occupational Exposure Assessment using Biomonitoring and Self-Reported Exposure Data in a Michigan Cohort**." Trainee: Amila Devasurendra; Advisor: Prof. Stuart Batterman. Dept. of Environmental Health Sciences, Univ. of Michigan School of Public Health.

The overall objective of the proposed project is to improve occupational exposure assessments for emerging toxic contaminants, specifically, polychlorinated naphthalenes (PCNs), which have been recently listed under the Stockholm Convention and for which little exposure data exists in the USA or worldwide. PCNs are a class of chlorinated polycyclic aromatic hydrocarbons (PAHs) that are present in many industrial chemicals and byproducts. They include 75 congeners, several of which are highly toxic, bioaccumulative and persistent. The proposed project will focus on (1) the development and validation of a sensitive method to detect and quantify PCNs by homologue group and selected congeners, focusing on the most prevalent and toxic species in biological specimens such as blood or plasma; (2) application of the method using archived plasma samples to develop preliminary statistics on PCN exposures in Michigan workers; and (3) comparison of biological monitoring results with occupational histories previously obtained for each Michigan worker to potentially identify specific jobs or activities associated with PCN exposure. In addition, the proposed study will provide advanced training in occupational exposure assessment methods to a junior researcher. The study will utilize biological samples and survey data that have been previously collected and appropriately stored, and which form part of a large case-control study of amyotrophic lateral sclerosis (ALS); these data form part of the University of Michigan ALS Patient Repository (UMAPR). Currently, the repository includes data and biospecimens from over 800 ALS patients and healthy controls drawn across Michigan. The study will, for the first time, explore the presence of PCNs in a cross-section of US workers, will utilize both surveys and biological monitoring data, which can address gaps in each method, and most significantly, lead to a better understanding of PCN exposure and risk.

3. "**Prevention of Needlestick Injuries Among Healthcare Workers in Liberia and Ghana: A Cross-sectional Mixed Methods Study**." Trainee: Laura Jean Ridge; Advisor: Prof. Marjorie McCullagh. Univ. of Michigan School of Nursing.

Needlestick injuries (NSIs) are a major occupational hazard for healthcare workers worldwide. The majority of NSIs take place in low- and middle-income countries (LMICs), but surveillance of NSIs in LMICs is limited. Preliminary data

indicate that Liberia and Ghana, both English-speaking, low-income countries in West Africa, have different NSI incidence and reporting, but it is not understood why, largely due to limited understanding of modifiable and non-modifiable risk factors. This explanatory sequential mixed-methods study will use both cross-sectional survey and interview data of healthcare workers to examine different NSI outcomes (injury management, reporting, follow-up). Survey data will be analyzed using descriptive and inferential statistics; interview data will be analyzed via content analysis. After being analyzed separately, survey and interview data will be merged to explore the experiences of workers with >2 NSIs in a year and workers who have not reported their NSIs. Results of this study will include the incidence of NSI among healthcare workers in these two countries, the rates of reporting, and the role of modifiable and nonmodifiable risk factors in NSIs. Results of this study may be used to identify characteristics of particularly vulnerable workers and suggest ways to protect them; it may also be used to identify important modifiable risk factors in the general worker population.

International partnership agreements were signed with professional associations in both host countries.

4. "**Toxicity Assessment of Welding Fume Metal Nanoparticle Components**." Trainee: Li Xia; Advisor: Jonathan Shannahan. School of Health Sciences, Purdue Univ.

Welding is an essential modern manufacturing technology, with 11 million welders worldwide and 110 million individuals exposed to welding fumes at their workplace. Importantly, there exists an occupational exposure risk to welding fume exposures with studies demonstrating exposure related lung dysfunction, asthma, bronchitis, cancer, and increased susceptibility to pulmonary infections. Welding fumes are a complex mixture consisting of primarily metal NPs, such as iron (Fe), manganese (Mn), and others. These metal NPs are able to deposit deep within the lung inducing oxidative stress and inflammation resulting in pulmonary injury. Toxicity resulting from welding fume exposure is likely variable based on alterations in NP components of the fumes. Additionally, welders are known to be increasingly susceptible to pulmonary bacterial and viral infections due to exposure-induced immune dysregulation. This modulation of the immune system may also reduce viral vaccine effectiveness in this population. To examine toxicity associated with variations in NP components of welding fumes, we constructed a system for the controlled and continuous generation of NPs from welding electrodes for in vitro exposure studies. For the proposed study, NP mixtures will be produced from highly utilized commercially available electrodes (6010, 6012, 7024). To perform hazard assessments of the NP components, human lung epithelial cells and macrophages will be grown individually and transitioned to air-liquid-interface. Human fibroblasts will be grown in the basolateral compartment and will interact with signaling molecules released from cells in air-liquid-interface. NP aerosols will be characterized in real-time during exposures for size, composition, and morphology. Cells will be exposed to two human-relevant concentrations of freshly aerosolized NPs for 8 h and endpoints of toxicity will be evaluated. In aim 1, cells will be examined for differential toxicity due to alterations in aerosolized NP components. The endpoints analyzed include cytotoxicity, internalization of NPs, and alterations in markers of oxidative stress, inflammation, and fibrosis. Aim 2 will evaluate bacterial and viral susceptibility risks following welding fume exposures through challenging exposed cells with lipopolysaccharide (LPS) to model gramnegative bacteria or the live attenuated influenza virus (FluMist). Completion of this proposed research will result in the generation of new knowledge regarding hazards associated with the NP component of welding fumes and their impact on infection risk. This information will allow for a more thorough understanding of disease associated with occupational exposure to welding fumes and can be applied to regulations, prevention strategies, and therapeutic strategies.

The investigators generated reliably a spectrum of nanoparticles of the appropriate size distribution, with varying concentrations of several metals, and exposed human lung cells in culture to these mixtures.

5. "**Evaluating Occupational Biohazards, Stress, and Readiness for Uptake of Total Worker Health Interventions in U.S. Waste Workers**." Trainee: Aurora Le; Advisor: Assoc. Prof. Richard Neitzel. Dept. of Environmental Health Sciences, Univ. of Michigan School of Public Health.

Waste workers experience occupational hazards daily. Particularly, solid and medical waste workers are exposed to bioaerosols, bloodborne pathogens, and human and animal excrements in the process of collecting, sorting, and disposing waste. In tandem, the constant chronic biological occupational exposures can result in elevated stress. Occupational stress, in turn, can result in increased injury and illness rates among workers. Significant research, both in and outside of the United States, has been conducted on waste workers regarding their chemical and ergonomic occupational exposures. However, information about the biological exposures of U.S. waste workers and their associated workplace stress is limited despite comparable risks to biohazards as healthcare workers. Evidence suggests that Total Worker Health (TWH) approaches are efficacious in addressing both the physical and psychosocial stressors of the workplace, but to our knowledge, this has not been explored among U.S. waste workers. Consequently, the proposed pilot study aims to address the aforementioned research gaps. We propose a comprehensive assessment of a sample of U.S. solid and medical waste workers to determine occupational biohazard exposures and knowledge and training to mitigate these hazards. Additionally, perceived occupational stress and readiness for uptake of TWH interventions will be measured using existing validated assessment tools. Perceived selfreported stress will be compared to the worker's physiological stress via collection of saliva samples to analyze cortisol levels. The proposed study will create the foundation for a longterm collaboration between the university researchers and national stakeholders in the waste industry. Furthermore, it will generate pilot data for use in future development of TWH interventions, as well as bolstered biohazard training and education to improve the health, safety, and wellbeing of this overlooked yet vulnerable population of workers in solid and medical waste.

Sixty-eight subjects were recruited, at three different solid waste or recycling facilities in SE Michigan, and survey data and saliva samples were collected from respondents. The data revealed widespread injuries (cuts, lacerations) in this cohort, and concern among workers about the inadequacy of safety/health programs at their worksite.

In June 2020, we funded four projects. These projects are listed below with a summary of the aims and accomplishments.

1. "**Assessment of Occupational Exposure to Pesticides using Biological Monitoring and Self-Reported Exposure Data in a Michigan Cohort**". Trainee: Sung-Hee Seo, University of Michigan SPH; Mentor: Prof. Stuart Batterman.

This project explored exposure to organophosphate pesticides (OPs) among several groups of workers as well as members of the general public. The investigators first developed and validated a method to measure biomarkers of pesticide exposure in urine samples. The method measured six metabolic derivatives of Ops—dimethylphosphate (DMP), diethylphosphate (DEP), dimethylthiophosphate (DMTP), dimethyldititihiophosphate (DMDTP), diethylthiophosphate (DETP), and diethyldithiophosphate (DEDTP)—using gas chromatography electron impact triple-quadrupole mass spectroscopy (GC/MS-MS), and isotope dilution. The method achieved high selectivity, good signal-to-noise and sensitivity, and showed relatively little matrix interference. Next, they selected urine samples for analysis from 72 individuals drawn from a large case-control study, which had also included the collection of a wide range of exposure information using questionnaires. Individuals were selected in four groups: those reporting pesticide exposure at work, at home, at both work and home, or neither, all based on questionnaire responses. The investigators documented higher concentrations of several diethyl OPs in workers as compared to non-workers, but the opposite with respect to some of the dimethyl Ops. They are currently preparing two manuscripts for submission to peer review. The trainee reports a very positive experience learning more about occupational health and its importance (her prior research experience largely dealt with analyzing biomarkers of exposure in the general population).

2. "**Development of a Sampler for the Rapid and Convenient Detection of Airborne Pathogens**". Trainee: Li Liao, Purdue University; Mentor: Prof. Jae Hong Park.

These investigators have begun to develop and validate a novel sampling method for the rapid (< 30 min, as compared to conventional methods needing 24 hrs or more) detection of airborne pathogens. The method collects

bioaerosols directly onto a single-use swab that directly connects to an immunochromatographic assay. The researchers were able to detect concentrations of Legionella pneumophilia at levels as low as approximately 4000 colony forming units, levels that conventional methods could not reliably detect.

The study was delayed due to the Covid-19 pandemic, but the investigators plan to continue their work using other pathogens to see if the sampler can be of generalized use.

3. "**Computer Vision Predicts Force during Lifting**". Trainee: Guoyang Zhou, Purdue University; Mentor: Assistant Prof. Denny Yu.

The Purdue researchers developed an innovative method, combining multiple video cameras with machine learning algorithms, to assess physical stress during lifting without having to measure (intrusively) the actual forces the worker applies and the positions s/he assumes. They developed equations to combine predicted physical stresses (based on posture, velocity, and other factors) and subjects' responses to the movement (based on analysis of facial expressions during the lifting), whose output was a prediction of the difficulty and injury risk of the lift. They validated the predictions by comparing their outputs to both the NIOSH lifting equation (using known values of weight, angle, velocity, etc.) and to subjects' reported perceived exertion level during the lift.

This project has already resulted in two publications with the Institute of Electrical and Electronics Engineers (IEEE): (1) an article entitled "A computer vision approach for estimating lifting load contributors to injury risk," in review at the journal IEEE Transactions on HumanMachine Systems; and (2) an abstract presented at the 2021 IEEE Systems, Man, and Cybernetics Society meeting.

4. "**A Deep-Learning-Based Computer Vision System for Asymmetry Angle Estimation**". Trainee: Zhengyang Lou, University of Madison-Wisconsin; Mentor: Prof. Robert G. Radwin.

These researchers developed a method that requires only a single camera to measure body asymmetry during manual lifting, but that can nevertheless assess asymmetry over all three spatial dimensions. The predictions made by their system were within several degrees of the ground-truth measurements. This project has already yielded two publications: (1) an article submitted to Human Factors; and (2) an abstract presented at the Triennial Congress of the International Ergnonomics Association, June 2021. The researchers have also applied for an R01 NIOSH grant to continue their work.

Due to the Covid-19 pandemic, we provided no-cost extensions to projects initiated in 2019. These projects provided final reports and a number of accomplishments in the 2020-2021 reporting period.

1. "**Manganese from Nanoparticles in Welding Fumes**" Jae Hong Park, Purdue

Hypothesis: that exposure to nano-size Mn in welding fumes is better correlated with amount of Mn deposited in the brain than is exposure to respirable Mn. Approach and findings: They recruited 11 welders and 3 controls, exposed to Mn levels below the PEL but above the TLV. They found correlations between nano-sized Fe concentrations and deposition in the globus pallidus of the brain, but as yet no such correlations for Mn.

Awards and publications: Received an NIEHS R01 of approx. $3 M to continue their work Won Best Student Poster in the *AIHA Oil and Gas Working Group* at the June 2020 AIHce conference.

1. "**A Smartphone-based Hearing Conservation Intervention for Farm and Rural Youth**" Khalid Khan, Indiana Univ. (Bloomington)

Hypothesis: that a smartphone app might improve hearing conservation behavior more effectively than traditional print-based education. Approach and findings: They recruited 58 young people (13-18 years old) who work on farms, and either gave them the NIOSH Sound Level Meter app and a demonstration, or gave them brochures only.

Although neither group reported increased use of hearing protection, the experimental group improved their scores on a test of knowledge about hearing loss slightly more so than the control group did.

Awards and publications: The PI is currently applying for grants from NIDCD and from NIOSH (R21).

2. "**Migrant and Seasonal Farmworker's Health and Labor: Building a Foundation for Community-Based Participatory Research in Michigan**" Lisbeth Iglesias-Rios, Siobán Harlow, University of Michigan

Hypothesis: that in-depth interviews will show that migrant and seasonal farmworkers face a range of social and occupational stressors affecting their mental health, substandard living conditions, excessive working conditions, lack labor protections, and a wide range of occupational and living hazards that have resulted in adverse health outcomes. Approach and findings: They interviewed 34 farmworkers (in Spanish) and "found a range of indicators of precarious employment and exploitative working conditions that have placed farmworkers at a disadvantage in terms of their physical and mental health.

Accomplishments: They were recently awarded a contract with the US Dept of Housing and Urban Development to assess housing conditions among these farmworkers during the pandemic. Publications include: Handal, Alexis J., L. Iglesias-Rios, P.J. Fleming, M.A. Valentin-Cortes, and M.S. O'Neill (2020). " 'Essential' but Expendable: Farmworkers during the COVID-19 Pandemic." *American Journal of Public Health,* 110(12): 1760-2

3. "**Survey of One-Handed Lifting in the Manufacturing Industry: A Cross-sectional Study of the Back Works Study Cohort**" Jay Kapellusch, Ruoliang Tang, University of Wisconsin-Milwaukee

Hypothesis: One-handed lifting (OHL) poses different ergonomic hazards than the more common two-handed lifting (THL). Approach and findings: They measured 1,359 job tasks among 623 workers, and found that compared to THL, OHL tasks tended to involve less weight but greater trunk twisting and lateral bending.

Accomplishments: Publications include:

- Tang, R., Kapellusch, J.M., Merryweather, A.S., Thiese, M.S., Hegmann, K.T., Ferguson, S.A., Marras, W.S., Lu, M-L. (2020, In-Press). "Survey of One-handed Lifting in Manufacturing Industry: A Cross-sectional Study of the BackWorks Study Cohort." *Proceedings of the 2020 HFES (Human Factors and Ergonomics Society) Annual Meeting and Conference.*

4. "**Health Effects of Occupational Exposure of Wildland Firefighter to Smoke: Beyond Wildland Fire Smoke and Pulmonary System**" Chieh-Ming Wu, Olorunfemi Adetona, Ohio State University

Hypothesis: Firefighters exposed to wildfire smoke particulate (WFS) versus diesel exhaust particulate (DEP) may experience different cellular responses. Approach and findings: They recruited 39 firefighters and found that WFS exposure was associated with significantly higher heart rate but lower blood pressure. The *in vitro* measurements of cellular responses were delayed due to the Covid pandemic and will be conducted in early 2021.

Accomplishments include the following publications:

- Wu, Chieh-Ming, Sarah H Warren, David M DeMarini, Chi (Chuck) Song, and Olorunfemi Adetona (2020). "Urinary Mutagenicity and Oxidative Status of Wildland Firefighters Working at Prescribed Burns in a Midwestern US Forest." *Occupational and Environmental Medicine*, 0: 1-8, doi:10.1136/oemed-2020-106612.

- Wu, Chieh-Ming, Chi (Chuck) Song, Ryan Chartier, Jacob Kremer, Luke Naeher, and Olorunfemi Adetona (2021). "Characterization of Occupational Smoke Exposure among Wildland Firefighters in the Midwestern United States." *Environmental Research,* 193: 1-9.

In June 2018, we funded four projects. These project summaries are listed below.

1. "**Occupational Risk Factors on Head and Neck Cancer in Northeast Thailand**." Trainee: Ilona Argirion Advisor: Ass. Prof. Laura Rozek. School of Public Health, University of Michigan.

In this study, patients from Srinagarind Hospital in Khon Kaen, Thailand (a high incidence area for HNC) were recruited to participate in a case-control study aimed at developing a tool to aid in elucidating the role of occupational exposures on head and neck cancer development. A questionnaire, developed by experts at the University of Michigan and Khon Kaen University, and based on previous work by the National Case Control Study of Mesothelioma in Relation to Occupation and the National Study of Occupation and Lung Diseases, to collect lifetime occupational exposure data for study participants. Incident cases of HNC were approached, consented, and asked to provide responses to questionnaires about their demographics, risk factors and lifetime occupational exposures. A prior knowledge, based on extensive literature review, was utilized to determine a list of 'high risk' occupations; if a patient participated in a high-risk occupation, further questions about exposures were asked. Additional clinical data was collected from cases and tumor blocks (in the form of formalin fixed, paraffin embedded tissue) were collected and stained for p16 to exclude high risk human papilloma virus as an etiological factor. Age (within 2 years), gender and subdistrict matched controls were identified with the help of the health services registry. Local community health workers compiled a random list of potential controls (at least 10 per case). Each potential control was approached by a study team member and asked to participate in the study. Upon informed consent, each control was asked to complete the same questionnaires given to the cases. Once cases and controls were ascertained, a meeting, attended by occupational physicians, industrial hygienists, epidemiologists and head and neck cancer surgeons, was held to standardize occupational and industrial coding, as well as develop a job-exposure matrix that could be used to determine risk of occupational exposure.

The resulting product from this pilot study uses standardized occupational and industrial coding, in conjunction with exposure probability, intensity, duration and latency to determine whether or not an individual was occupationally exposed to a potential etiological factor relevant to HNC development. This tool has been integrated into a larger case-control study established in Khon Kaen for future epidemiological use.

2. "**Implementation and Assessment of Exoskeletons for Reducing Risks for Musculoskeletal Disorders in Surgery**." Trainee: Jackie Cha Advisor: Ass. Prof .Denny Yu . School of Industrial Engineering, Purdue University.

A two-phase study was completed to 1) gain insight into the stakeholder's perspectives on passive exoskeletons, specifically arm-support devices, and 2) evaluate the effects of wearing the exoskeleton on muscle activity and posture using wearable sensors and self-reported questionnaires. Fourteen participants were recruited for focus groups and structured interviews (i.e., surgeons, surgical trainees, and surgical nurses). Four themes were identified related to the adoption of exoskeletons in the OR: characteristics of individuals, benefits, environmental/societal factors, and intervention characteristics. Pilot data of using the exoskeleton in the OR found few changes in self-reported discomfort; an increase in overall and right upper arm discomfort was noted after wearing the exoskeleton. Marginally acceptable usability of the exoskeleton was reported from the participants through the System Usability Scale.

In conclusion, four themes were identified encompassing facilitators of and obstacles to surgical team members using exoskeletons in Phase 1. Specially, this study focused on gaining perspective from all stakeholders in the OR, especially the surgical team members that are also exposed to ergonomic injury risks yet received less attention than surgeons. Preliminary results from Phase 2 show marginally acceptable usability of the exoskeletons in the OR, and analysis is on-going to determine biomechanical impact of the intervention in the field. Exoskeleton intervention received positive sentiment especially from the nursing role. Thus, exoskeleton technology has the potential in this work environment decrease MS symptoms for all team members. Although adoption of arm-support exoskeletons can be valuable; a key contribution of this initial work is the identification of unique aspects of the surgical environment and barriers and facilitates that can guide translation of exoskeletons into wide-spread practice.

3. "**Occupational Inhalation Exposure to and Health Risk of Volatile Organic Compounds of Hotel Housekeepers**." Trainee: Nan Lin Advisor: Prof. Stuart Batterman. School of Public Health, University of Michigan.

Although identified as a high priority risky group by the NIOSH Total Worker Health initiative and others, hotel housekeepers represent an under-researched population, and their inhalation exposures are poorly explored. In this pilot study, we evaluated hotel housekeepers' inhalation exposure to VOCs in daily work to fill this data deficiency and assessed their occupational health risk. We collected 13 area samples and 23 personal VOC samples at 2 hotels in 3 seasons. Temperature, relative humidity and CO2 were continuously monitored. VOCs in 7 products used in the studied hotels were analyzed by purge and trap methods. Hazard ratios (HRs) and excess cancer risks (CRs) were calculated based on personal exposure level and reference value from EPA and Michigan Department of Environment, Great Lakes, and Energy (EGLE). Personal samples had higher VOC levels than indoor area samples in hotels with the total VOC concentration of 57 ± 35 μg/m3 (average ± standard deviation) compared to 28 ± 15 μg/m3.

Personal samples were more accurate than area samples when assessing occupational exposure. In addition to the VOCs in laundry and cleaning products, housekeepers are exposed to disinfection byproducts in tap water, especially laundry workers. Although non-cancer health risks of hotel housekeepers were not high, cancer risks exceeded some benchmarks. Most of the cancer risk is due to exposure to formaldehyde. Exposures can be reduced by improving ventilation, and reducing or removing toxic constituents in laundry and cleaning products.

4. "**A Manual Lifting Worker Tracking Monitor Using Motion Based Computer Vision**." Trainee: Xuan Wang, Advisor: Prof. Robert Radwin. School of Engineering, University of Wisconsin-Madison.

We have explored using photogrammetric range imaging techniques for estimating the asymmetric angle in manual lifting. Various approaches to estimate the asymmetric angle were explored thoroughly, expanding from silhouette-based 3D contour mesh mask estimation, image rectification, traditional structure from motion, and improved structure from motion by combining a convolutional neural network (CNN) based 2D human skeletal joints estimator, "Openpose." The approach of combining structure from motion and Openpose was the most robust and reliable approach. It employs two cameras, and the 2D skeletal joint estimation from each camera view are taken as input to the structure from motion. This combination contributes the following: 1. structure from motion into 3D human pose estimation, 2. enhanced accuracy of 2D skeletal joints estimation, 3. united estimation in both 2D and 3D, 4. avoids wearable sensors and providing more equipment flexibility for practical application. The study shows this approach provides the asymmetry angle estimation with a mean difference angle 5.5°, and standard deviation 10.6°. Factors that lead to the biased estimation are discussed and further improvements have been planned.

Key Outcomes

The PPRTP program achieved its objective of funding high-quality pilot projects focused on important issues in occupational health and safety. The funded projects in this cycle represent four key disciplinary areas within OSHS (occupational ergonomics, occupational infectious disease, acute injury, and industrial hygiene exposure assessment), and address topics relevant to workers in HHS Region V and across the US. In particular, current projects address Total Worker Health (stress and well-being among waste workers) and involve partnerships in the developing world to aid workers in those countries directly but also to shed light on underserved workers in Region V. Achievements may be grouped into three categories: (1) publications in archival journals, publications in conference proceedings, and oral presentations at professional/research meetings; (2) proposals developed as a result of PPRTP research activities; and (3) placement of PPRTP trainees in research positions in academia, government and the private sector. These achievements are difficult to assess over a single one-year period. However, since the inception of the PPRTP in 1999, our program has been quite successful by these measures, as evidenced by the following (data through Nov. 2022):

- 77 of 104 projects had a doctoral student or postdoctoral fellow as the research trainee.
- 14 pilot project trainees accepted new positions as faculty members in academic institutions.
- 1 patent disclosure has been filed.
- 138 manuscripts have been published, at least 56 presentations delivered, and 26 R01 or R21 grants have been awarded to research trainees.

B.3. Competitive Revisions/Administrative Supplements
N/A

B.4. What opportunities for training and professional development did the project provide?

Each funded project explicitly addresses mentorship, training, and professional development for the trainee. An individual is eligible to receive only one grant as a pilot project research trainee over the course of his/her career. Since 2017, we have required that all research trainees must receive mentorship for their project. Doctoral and postdoctoral trainees may be mentored by any member of their institution's graduate faculty. Junior faculty research trainees must receive mentorship from a tenured faculty member.

We also require that awardees present their project at our annual Regional ERC Research Symposium. Attendance is also required for all master's and doctoral-level trainees funded by the UM ERC, providing opportunities for researchers and students to interact and engage with each other. These regional symposia attract over 100 attendees, and provide a unique and effective opportunity for training and professional development for PPRTP-funded researchers as well as OHS-focused students, faculty, and staff.

The 2023 Regional Education Research Center (ERC) Symposium, was held on Friday April, 14th 2023 at the University of Michigan Union building, in Ann Arbor, Michigan. This year's theme "Meeting Challenges in Occupational and Environmental Justice" with guest speakers from EPA, Blue Green Alliance, Green Door Initiative, Boston University, and the Erb Family Foundation. Regional ERC updates on EJ work being done in each state, and afternoon ignite-style collaborative workshop and group presentations. This event brought over 90 interdisciplinary and intercollegiate NIOSH trainees and faculty together for this yearly scheduled research symposium and poster session from the Education and Research Centers from the University of Cincinnati, University of Illinois Chicago and the University of Michigan. Program Objectives included; Describing the prevalence and impacts of occupational and environmental injustices; Recognize that environmental injustices are often dwarfed by occupational injustices, and that reducing only environmental injustices may not significantly improve overall justice; Evaluate needs and opportunities for OSH and EHS education and training on occupational injustices; and discuss research and policy initiatives that could help integrate occupational risk reduction into EJ

2023 symposium overview and presentations: https://cohse.umich.edu/other-events-tours/research-symposium/2023-research-symposium/

B.5. How did you disseminate the results to communities of interest?

PPRTP results are disseminated in three ways. First, the primary outputs for each funded PPRTP project are scholarly publications and presentations at technical and professional conferences. All PPRTP trainees are required to submit a final report summarizing their research projects, and are encouraged to submit these for publication in peer-reviewed publications. We track published manuscripts and technical and professional publications by reaching out to current and former PPRTP trainees annually to request this information.

Second, all PPRTP projects are required to submit a 2-3 paragraph, lay-language vignette regarding the funded research that can be disseminated to a broad audience of occupational health practitioners, policymakers, and the general public. This statement addresses what problem was evaluated, why this problem is important, what the research project showed, and what the practical relevance and ramifications of the research are. The statement is

accompanied by photos or other graphical material with captions. We post these statements and photos on our public PPRPT website for both current and past projects.

Third, as described, PPRTP trainees are required to attend our annual ERC research symposium and to present their research. Collectively, we believe these dissemination efforts allow us to reach our target communities, i.e., occupational health and safety researchers and practitioners in HHS Region V, around the US, and globally.

B.6 - What do you plan to do during the next reporting period to accomplish the goals?

The PPRT Program in the past five years has greatly increased the proportion of trainees who are women and/or who come from historically disadvantaged groups. We believe, however, that our program can be even more effective in addressing problems of insufficient inclusion and equity if we also focus on the *subjects* of PPRT research. Accordingly, we have encouraged recent applicants to aim their investigations so as to highlight and remedy these disparities. In just the past three years, we have funded projects aimed at rural youth workers, migrant farmworkers, landfill and waste collection workers, HCWs in two developing countries in Africa, older workers with mobility limitations, and African-American caregivers for dementia patients. We intend to continue this focus, and perhaps explicitly give additional evaluation points to proposals that target historically-disadvantaged populations for study or outreach.

Another focus of considerable attention throughout COHSE, with direct benefits for improving the PPRT program, has involved the complete rebuild of the Center's Website. We are now able to translate PPRT research results into easily-summarized vignettes online, and can provide continuous updates on publications and grants emerging from completed PPRT work. The new website also contains an enhanced search tool that keeps track of research published by COHSE faculty and affiliates.

C. PRODUCTS

C.1. Publications, conference papers, and presentations

Ilona Argirion:

Publications

Argirion I, Zarins KR, McHugh J, Cantley RL, Teeramatwanich W, Laohasiriwong S, Kasemsiri P, Naruikon J, Srimanta P, Chinn SB, Vatanasapt P, Rozek LS. Increasing prevalence of HPV in oropharyngeal carcinoma suggests adaptation of p16 screening in Southeast Asia. *J Clin Virol*. 2020 Nov; 132:104637

Argirion I, Zarins KR, Suwanrungruang K, Pongnikorn D, Chitapanarux I, Sriplung H, Vatanasapt P, Rozek LS. Subtype Specific Nasopharyngeal Carcinoma Incidence and Survival Trends: Differences between Endemic and Non-Endemic Populations. *Asian Pac J Cancer Prev*. 2020 Nov 1; 21(11):3291-3299

Argirion I, Zarins KR, Defever K, Suwanrungruang K, Chang JT, Pongnikorn D, Chitapanarux I, Sriplung H, Vatanasapt P, Rozek LS. Temporal Changes in Head and Neck Cancer Incidence in Thailand Suggest Changing Oropharyngeal Epidemiology in the Region. *J Glob Oncol*. 2019 Mar; 5:1-11

Grants

Project Leader: Maureen Agnes Sartor
Other PIs: Laura Rozek et.al.
Downstream effects of HPV integration on survival/metastasis in oropharyngeal cancer

Project number: 5R01CA250214-03
University of Michigan at Ann Arbor
Grant agency: National Cancer Institute (NCI)
Amount: $584,593

Jackie Cha:
Publications

Gonzales A, Lin JH, Cha JS. Physical activity changes among office workers during the COVID-19 pandemic lockdown and the agreement between objective and subjective physical activity metrics. *Applied Ergonomics* 2022; 105, 103845

Cha JS, Athanasiadis DI, Peng Y, Wu D, Anton NE, Stefanidis D, Yu D. Objective Nontechnical Skills Measurement Using Sensor-based Behavior Metrics in Surgical Teams. *Hum Factors*. 2022 May 24:187208221101292

Anton NE, Whiteside JA, Cha J, Perkins LA, Martin M, Stefanidis D. Characterizing Robotic Surgical Expertise: An Exploratory Study of Neural Activation During Mental Imagery of Robotic Suturing. *The American Journal of Surgery* 2021; 222(6), 1131-1138

Cha JS, Athanasiadis D, Anton NE, Stefanidis D, Yu D. Measurement of Nontechnical Skills During Robotic-Assisted Surgery Using Sensor-Based Communication and Proximity Metrics. *JAMA Netw Open*. 2021 Nov 1;4(11):e2132209

Wu C, Cha J, Sulek J, Sundaram CP, Wachs J, Proctor RW, Yu D. Sensor-Based Indicators of Performance Changes Between Sessions During Robotic Surgery Training. *Appl Ergon*. 2021 Jan; 90:103251

Wu C, Cha J, Sulek J, Zhou T, Sundaram CP, Wachs J, Yu D. Eye-Tracking Metrics Predict Perceived Workload in Robotic Surgical Skills Training. *Hum Factors*. 2020 Dec; 62(8):1365-1386

Cha JS, Monfared S, Stefanidis D, Nussbaum MA, Yu D. Supporting Surgical Teams: Identifying Needs and Barriers for Exoskeleton Implementation in the Operating Room. *Hum Factors*. 2020 May;62(3):377-390

Cha JS, Monfared S, Ecker K, Lee D, Stefanidis D, Nussbaum MA, Yu D. Identifying Barriers and Facilitators of Exoskeleton Implementation in the Operating Room. *Proc Hum Factors Ergon Soc Annu Meet.* 2019 Nov 20;63(1):1113

Cha J, Gonzalez G, Sulek J, Sundaram C, Wachs J, Yu D. Measuring Workload Through EEG Signals in Simulated Robotic Assisted Surgery Tasks. Conference Abstract: 2nd International Neuroergonomics Conference. 2018; 36

Peng Y, Anton NE, Cha JS, Mizota T, Hennings JM, Stambro RP, Rendina MA, Stanton-Maxey KJ, Stefanidis D. Automated Communication Assessments Predict Acute Care Team Simulation Performance. *Journal of the American College of Surgeons* 2018; 227(4), e49

Nan Lin:
Publications

Lin N, Rosemberg MA, Li W, Meza-Wilson E, Godwin C, Batterman S. Occupational Exposure and Health Risks of Volatile Organic Compounds of Hotel Housekeepers: Field Measurements of Exposure and Health Risks. *Indoor Air*. 2021 Jan; 31(1):26-39

Xuan Wang:
Publications

Greene RL, Lu ML, Barim MS, Wang X, Hayden M, Hu YH, Radwin RG. Estimating Trunk Angle Kinematics During Lifting Using a Computationally Efficient Computer Vision Method. *Hum Factors*. 2022 May; 64(3):482-498

Wang X, Hu YH, Lu ML, Radwin RG. Load Asymmetry Angle Estimation Using Multiple View Videos. *IEEE Trans Hum Mach Syst*. 2021 Dec; 51(6):734-739

Wang X, Hu YH, Lu ML, Radwin RG. The Accuracy of a 2D Video-Based Lifting Monitor. *Ergonomics*. 2019 Aug; 62(8):1043-1054

Greene RL, Hu YH, Difranco N, Wang X, Lu ML, Bao S, Lin JH, Radwin RG. Predicting Sagittal Plane Lifting Postures from Image Bounding Box Dimensions. *Hum Factors*. 2019 Feb; 61(1):64-77

Grants
Project Leader: Robert G. Radwin
Grant name: A Computer Vision Lifting Monitor
Project number: 1R01OH012313-01A1
University of Wisconsin – Madison
Grant agency: NIOSH
Amount: $525,630

Chieh-Ming Wu:
Publications
Wu CM, Adetona O, Song C. Acute Cardiovascular Responses of Wildland Firefighters to Working at Prescribed Burn. *Int J Hyg Environ Health*. 2021 Aug; 237:113827

Wu CM, Song CC, Chartier R, Kremer J, Naeher L, Adetona O. Characterization of Occupational Smoke Exposure among Wildland Firefighters in the Midwestern United States. *Environ Res*. 2021 Feb;193:110541

Wu CM, Adetona A, Song CC, Naeher L, Adetona O. Measuring Acute Pulmonary Responses to Occupational Wildland Fire Smoke Exposure Using Exhaled Breath Condensate. *Arch Environ Occup Health*. 2020; 75(2):65-69

Wu CM, Warren SH, DeMarini DM, Song CC, Adetona O. Urinary Mutagenicity and Oxidative Status of Wildland Firefighters Working at Prescribed Burns in a Midwestern US Forest. *Occup Environ Med*. 2020 Nov 2: oemed-2020-106612

Grants
Project Leader: Olorunfemi Adetona
Grant name: Chronic Respiratory Effect and Control of Occupational Exposure of Wildland Firefighters to Smoke
Project number: 1R01OH012224-01A1
Ohio State University
Grant Agency: NIOSH
Amount: $585,689

Khalid Khan:
Publications
Bielko SL, Khan KM, Weigel MM. Perceptions, Beliefs, and Attitudes Toward Various Hearing Conservation Approaches Reported by Indiana College Agriculture Students. *J. of Agricultural Safety and Health* 2020; 26(4), 109-122

Khan KM, Bielko SL, McCullagh MC. Efficacy of Hearing Conservation Education Programs for Youth and Young Adults: A Systematic Review. *BMC Public Health*. 2018 Nov 22; 18(1):1286

Grants
Project Leader: Marjorie McCullagh
Grant name: Complexity: Innovations in Promoting Health through Team Science

Project number: 2T32NR0v16914-06
University of Michigan at Ann Arbor
Grant agency: National Institute of Nursing Research
Amount: $210,305

Jae Hong Park:
Publications
Lee, C.G., Lee, J.H., Liu, S., Dydak, U., Park, J.H. Feasibility of using inductively coupled plasma-optical emission spectrometry to analyze metals in toenails. Society of Toxicology 61th Annual Meeting and ToxExpo. 2022. San Diego, California, USA

Klicker-Wiechmann, J.R., Lee, C.G., Lee, J.H., Dydak, U., Liu, S., Park, J.H. New approach to analyzing the size distribution of metallic aerosols in welding fumes. American Industrial Hygiene Conference and Exposition (AIHce). 2022. Nashville, Tennessee, USA

Lee, C.G., Klicker-Wiechmann, J.R., Dydak, U., Liu, S., Park, J.H. Comparison of size distributions of particles in steel and aluminum welding fumes. American Industrial Hygiene Conference and Exposition (AIHce). 2022. Nashville, Tennessee, USA

Lee, C.G., Bobo, T., Prasad, K.A., Theis, M.A., Snyder, S., Lee, J.H., Liu, S., Dydak, U., Park, J.H. Measurement of welders' exposures to welding fumes and metals in toenails. HHS Fall Research Day. 2021. West Lafayette, Indiana, USA

Lee, C.G., Lee, J.H., Liu, S., Dydak, U., Park, J.H. Feasibility of using inductively coupled plasma-optical emission spectrometry to analyze metals in toenails. 3rd Annual HSCI Research Retreat. 2022. West Lafayette, Indiana, USA

Klicker-Wiechman, J.R., Lee, C.G., Lee, J.H., Dydak, U., Liu, S., Park, J.H. New approach to analyzing the size distribution of metallic aerosols in welding fumes. UIUC & UF American Association for Aerosol Research (AAAR) Student Research Symposium. 2022. Virtual

Grants
Project Leader: Ulrike Dydak
Neuroimaging of Manganese Toxicity
Project number: 5R01ES032478-02
Purdue University
Grant agency: National Institute of Environmental Health Sciences (NIEHS)
Amount: $550,790

Ruoliang Tang:
Publications
Tang R, Kapellusch JM, Hegmann KT, Thiese MS, Wang I, Merryweather AS. Evaluating Different Measures of Low Back Pain Among U.S. Manual Materials Handling Workers: Comparisons of Demographic, Psychosocial, and Job Physical Exposure. *Hum Factors*. 2022 Sep; 64(6):973-996

Tang R, Kapellusch JM, Merryweather AS, Thiese MS, Hegmann KT, Ferguson SA, Marras WS, Lu ML. Survey of One-handed Lifting in Manufacturing Industry: A Cross-sectional Study of the BackWorks Study Cohort. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 2020; 64(1), 942-946

Lisbeth Iglesias-Rios:

Publications

Handal AJ, Iglesias-Ríos L, Fleming PJ, Valentín-Cortés MA, O'Neill MS. "Essential" but Expendable: Farmworkers During the COVID-19 Pandemic-The Michigan Farmworker Project. *Am J Public Health*. 2020 Dec; 110(12): 1760-1762

Li Liao:

Publications

Liao L, Luo ZQ, Byeon JH, Park JH. Size-selective sampler combined with an immunochromatographic assay for the rapid detection of pathogenic bioaerosols.
Society of Toxicology 61th Annual Meeting and ToxExpo. 2022. San Diego, California, USA

Bovenschen, A.W.G., Pecoraro, N.A., Liao, L., Park, J.H. Determining the lower detection limits of *legionella* test kits used in the air sampling device. Purdue Undergraduate Research Conference. 2022. West Lafayette, Indiana. USA

Pecoraro, N.A., Bovenschen, A.W.G., Liao, L., Park, J.H. Designing an impactor to collect pathogenic bioaerosols using a simulation model**.** Purdue Undergraduate Research Conference. 2022. West Lafayette, Indiana. USA

Liao L, Byeon JH, Park JH. Size-selective sampler combined with an immunochromatographic assay for the rapid detection of pathogenic bioaerosols. C4E Environmental Research Expo. 2021. West Lafayette, Indiana. USA

Liao L, Byeon JH, Park, JH**.** Size-selective sampler combined with an immunochromatographic assay for the rapid detection of pathogenic bioaerosols. HHS Fall Research Day. 2021. West Lafayette, Indiana, USA

Zhengyang Lou:

Publications

Lou, Z., Zhan, Li, Y., Hu, Y. H., Lu, M. L., and Radwin, R., Monocular Body Asymmetry Angle Estimation Using Deep Learning Computer Vision Algorithms, *21st Triennial Congress of the International Ergonomics Association*, Vancouver, Canada, June, 2021

Sung-Hee Seo:

Publications

Seo SH, Choi SD, Batterman S, Chang YS. Health Risk Assessment of Exposure to Organochlorine Pesticides in the General Population in Seoul, Korea Over 12 Years: A Cross-Sectional Epidemiological Study. *J Hazard Mater*. 2022 Feb 15; 424(Pt B):127381

Grants

Project Leader: Eva Lucille Feldman
Other PIs: Stuart Batterman et.al.
Developing novel strategies for personalized treatment and prevention of ALS: Leveraging the global exposome, genome, epigenome, metabolome, and inflammasome with data science in a case/control cohort
Project number: 5R01NS127188-02
University of Michigan at Ann Arbor
National Institute of Neurological Disorders and Stroke **(**NINDS)
Amount: $984,329

Guoyang Zhou:

Publications

Zhou G, Aggarwal V, Yin M, Yu D. A Computer Vision Approach for Estimating Lifting Load Contributors to Injury Risk, *IEEE Transactions on Human-Machine Systems*. April 2022; vol. 52, no. 2, pp. 207-219

Zhou G, Nagle A, Takahashi G, Hornbeck T, Loomis A, Smith B, Duerstock B, Yu D. Bringing Patient Mannequins to Life: 3D Projection Enhances Nursing Simulation, *CHI Conference on Human Factors in Computing Systems*, 2022; 1-15

Kratzke IM, Zhou G, Mosaly P, Farrell TM, Crowner J, Yu D. Evaluating the Ergonomics of Surgical Residents During Laparoscopic Simulation: A Novel Computerized Approach. *Am Surg*. 2022 Jan 19:31348211047505

Asadi H, Zhou G, Aggarwal V, Yu D. Computer Vision Algorithm to Identify High Force Exertions. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 2020; 64(1) 1585-1586

Asadi H, Zhou G, Lee JJ, Aggarwal V, Yu D. A Computer Vision Approach for Classifying Isometric Grip Force Exertion Levels. *Ergonomics*. 2020 Aug; 63(8):1010-1026

Zhou G. Vision-based Lifting Load Estimation for Preventing Lifting Injuries. Purdue University Graduate School 2020

Grants
Project Leader: Denny Yu
Real-time non-intrusive workload monitoring-Integration of human factors in surgery training and assessment
Grant number: 5R21EB026177-02
Purdue University
Grant agency: National Institute of Biomedical Imaging and Bioengineering (NIBIB)
$183,111

Aurora Le:
Publications
Le, A.B., Shkembi, A., Tadee, A., Sturgis, A.C., Gibbs, S.G., Neitzel, R.L. (2023). Characterization of perceived biohazard exposures, personal protective equipment, and training resources among a sample of formal US solid waste workers: A pilot study. *Journal of Occupational and Environmental Hygiene.* https://doi.org/10.1080/15459624.2023.2179060

Shkembi, A., Le, A.B., Neitzel, R.L. (2023). Associations between poorer mental health with work-related effort, reward, and overcommitment among a sample of formal US solid waste workers during the COVID-19 pandemic. *Safety and Health at Work, 14*(1): 89-95.

Le AB, Shkembi A, Sturgis AC, Tadee A, Gibbs SG, Neitzel RL. Effort-Reward Imbalance among a Sample of Formal US Solid Waste Workers. *Int J Environ Res Public Health*. 2022 Jun 1;19(11):6791

Laura Ridge:
Publications
Ridge LJ, Liebermann EJ, Stimpfel AW, Klar RT, Dickson VV, Squires AP. The Intellectual Capital Supporting Nurse Practice in a Post-Emergency State: A Case Study *Journal of Advanced Nursing* 2022; 78(9), 3000-3011

Ridge LJ, Stimpfel AW, Klar RT, Dickson VV, Squires AP. Infection Prevention and Control in Liberia 5 Years After Ebola: A Case Study. *Workplace Health & Safety* 2021; 69(6), 242-251

Li Xia:
Publications
Alqahtani S, Xia L, Shannahan JH. Enhanced Silver Nanoparticle-Induced Pulmonary Inflammation in a Metabolic Syndrome Mouse Model and Resolvin D1 Treatment. *Part Fibre Toxicol*. 2022 Aug 6; 19(1):54

Xia L, Alqahtani S, Ferreira CR, Aryal UK, Biggs K, Shannahan JH. Modulation of Pulmonary Toxicity in Metabolic Syndrome Due to Variations in Iron Oxide Nanoparticle-Biocorona Composition. *Nanomaterials (Basel)*. 2022 Jun 11; 12(12)

Alqahtani S, Xia L, Jannasch A, Ferreira C, Franco J, Shannahan JH. Disruption of Pulmonary Resolution Mediators Contribute to Exacerbated Silver Nanoparticle-Induced Acute Inflammation in a Metabolic Syndrome Mouse Model. *Toxicol Appl Pharmacol*. 2021 Nov 15; 431:115730

Grants
Project Leader: Jonathan Henry Shannahan
Compromised Resolution of Inflammation following Nanoparticle Exposure in Metabolic Syndrome
Project number: 1R01ES033173-01A1
Purdue University
Grant agency: National Institute of Environmental Health Sciences (NIEHS)
Amount: $337,723

Richard Neitzel:
Grants
Project Leader: Richard L. Neitzel
Grant name: Exploring the Association between Occupational Noise Exposures and Injuries
Project number: 5R21OH011896-02
University of Michigan at Ann Arbor
Grant agency: NIOSH
Amount: $208,669

C.2. Website(s) or other Internet site(s) – include URL(s)
cohse.umich.edu

C.3. Technologies or techniques
N/A

C.4. Inventions, patent applications, and/or licenses
N/A

C.5. Other products and resource sharing
N/A

D. PARTICIPANTS

D.1. What individuals have worked on the project? Please include calendar, academic, and summer months.

Commons ID	S/K	Name	Degrees(s)	Role	Cal	Aca	Sum	Foreign	Country	SS

ADFINKEL (2020-present)	Y	Adam Finkel	BS, MS, SC.D	Program director	1.2	0.0	0.0			NA
RNEITZEL (2018-2020)	Y	Rick Neitzel	BS, MS, PhD	Program director	1.2	0.0	0.0			NA

D.2 Personnel updates

a. Level of Effort:
b. New Senior/Key Personnel: No
c. Changes in Other Support: No
d. New Other Significant Contributors:

E. IMPACT

E.1 - What is the impact on the development of human resources, if applicable?

The Pilot Project Research Training Program (PPRTP) has as its the primary goal strengthening the occupational health and safety research capacity of the United States by increasing the number and quality of scientists who undertake research in occupational health and safety (OHS) disciplines and who are motivated to remain in the field as a career path.

In achieving this goal, the Michigan ERC PPRTP is enhancing academic human resources with expertise and research skills in occupational health and safety. This in turn ensures a continuing pipeline of new OHS academic faculty who can train additional OHS professionals and conduct cutting-edge research to identify and address traditional and emerging occupational hazards.

E.2 - What is the impact the Public Health Relevance and Impact? The investigator should address how the findings of the project relate beyond the immediate study to improved practices, prevention or intervention techniques, legislation, policy, or use of technology in public health.

The Michigan ERC PPRTP serves trainees from all core academic areas within the ERC: Industrial Hygiene (IH), Occupational Health Nursing (OHN), Occupational Safety Engineering (OSE), and Occupational and Environmental Epidemiology (OEE), as well as trainees and faculty mentors from other institutions outside the University of Michigan. The PPRTP program has provided trainees with research training and experience that positions them to conduct cutting-edge OHS research, as well as to develop and disseminate new OHS knowledge, technologies, and practices.

F. CHANGES

F.1 – Changes in approach and reasons for change, including changes that have a significant impact on expenditures

N/A

F.2 - Actual or anticipated challenges or delays and actions or plans to resolve them

N/A

F.3 - Significant changes to human subjects, vertebrate animals, biohazards, and/or select agents

N/A

G. Special Reporting Requirements

G.1 Special Notice of Award Terms and Funding Opportunities Announcement Reporting Requirements

N/A

G.2 Responsible Conduct of Research

Because the PPRT program is in large part extramurally-focused (i.e., on non-UM affiliated investigators), we have had to rely on investigators' home universities to directly provide RCRS training, mentorship, and oversight for their trainees. We already require documentation that every trainee has completed an NIH-compliant RCRS course, and require that every PPRT project involving human subjects provide IRB documentation before the work begins.

At UM, all Michigan ERC trainees already are required to take either a 1-credit course in RCRS (EHS 510, https://sph.umich.edu/admissions/courses/course.php?courseID=EHS510, for IH and OEE trainees, also available to OHN trainees, see section [*IH.3 and OEE.3*]) or NURS 803 (https://www.coursicle.com/umich/courses/NURS/803/, for OHN trainees,), or two four-hour workshops hosted by the UM College of Engineering (for OSE students). Each of these courses and workshops include all NIH-required areas involved in RCRS.

Beginning in 2023, we modified the PPRT solicitation to have applicants confirm whether their home university requires course work in RCRS. For applicants from any college or university that does not require this training, we will explore the possibility of allowing those applicants, if they receive funding from the PPRT program, to virtually attend EHS 510 or NURS 803. This may not be possible due to the timing of these classes, which are typically offered in Fall semester, after the nominal July 1 start date of PPRT funding. We will also explore as an alternative the possibility of holding a hybrid (face-to-face plus virtual) meeting with all trainees and the PPRT director each year, to discuss the importance of disclosing/avoiding conflicts of interest, complying with all human-subjects requirements, avoiding plagiarism and misattribution, and the like. This would be an opportunity for the trainees to network and discuss RCRS issues that may arise in their specific projects. Both of these approaches would achieve the same goal – that is, ensuring that every PPRT trainee is well-versed in RCRS issues, and can provide documentation of their training in this area.

It is worth noting here that PPRT Director Prof. Finkel has had direct involvement in developing guidance for issues regarding conflicts of interest and author disclosures. He was instrumental in developing a COI and disclosure policy for the journal *Risk Analysis* in 2006-07, long before most other journals had done so, and he was a co-author on an article[1] that recommended substantial improvements in how clinical Consensus Statements reduce and disclose conflicts and biases. He has also recently conducted scholarship on other RCRS-relevant issues, including plagiarism and misquotation of published materials.[2]

G.3 Mentor's Research Report or Sponsor Comments

N/A

G.4 Human Subjects

G.4.a Does the project involve human subjects?
N/A

G.4.b Inclusion Enrollment Data
N/A

G.4.c ClinicalTrials.gov
N/A

Does this project include one or more applicable clinical trials that must be registered in ClinicalTrials.gov under FDAAA?
N/A

G.5 Human Subject Education Requirement

Are there personnel on this project who are newly involved in the design or conduct of human subject's research?

N/A

G.6 Human Embryonic Stem Cells (HESCS)

Does this project involve human embryonic stem cells (only hESC lines listed as approved in the NIH Registry may be used in NIH funded research)?

N/A

G.7 Vertebrate Animals

Does this project involve vertebrate animals?

N/A

G.8 Project/Performance Sites

REGENTS OF THE UNIVERSITY OF MICHIGAN- ANN ARBOR
3003 SOUTH STATE STREET
1st Floor Wolverine Tower
ANN ARBOR, MI 48109-1276
UNITED STATES

G.9 Foreign Component
PPRT pilot grants awarded with prior approval:

21-22 "**Prevention of Needlestick Injuries Among Healthcare Workers in Liberia and Ghana: A Cross-sectional Mixed Methods Study."** Trainee: Laura Jean Ridge; Advisor: Prof. Marjorie McCullagh. Univ. of Michigan School of Nursing.

International partnership agreements have been signed with professional associations in both host countries; an abstract has been submitted to the June 2022 World Health Organization's Nursing and Midwifery Conference.

18-19 "**Occupational Risk Factors on Head and Neck Cancer in Northeast Thailand**." Trainee: Ilona Argirion Advisor: Ass. Prof. Laura Rozek. School of Public Health, University of Michigan.

G.10 Estimated Unobligated Balance

See Final FFR

G.10.a Is it anticipated that an estimated unobligated balance (including prior year carryover) will be greater than 25% of the current year's total approved budget?

No

G.11 Program Income

Is program income anticipated during the next budget period?
N/A

G.12 F&A Costs

Is there a change in performance sites that will affect F&A costs?
N/A

I. OUTCOMES

I. Provide a concise summary of the outcomes or findings of the award, written for the general public in clear and comprehensible language, without including any proprietary, confidential information or trade secrets

Note: project outcome information will be made public in NIH RePORTER

The University of Michigan (UM) Education and Research Center (ERC) Pilot Project Research Training Program (PPRTP) offers an opportunity for early career investigators, as well as investigators new to the field of occupational health and safety (OHS) to develop or cement their interest in OHS, while conducting cutting-edge research with established faculty mentors. In an era in which public health in general, and occupational health specifically, are facing the challenges of an aging workforce, programs like PPRT can replenish the field and introduce young investigators to the personal and societal benefits of applied research. They can also serve to enhance diversity, equity, and inclusion (DEI) by offering an entry point into OHS for investigators and trainees from a variety of backgrounds.

The PPRTP was established at the Michigan ERC in 1999. During our 23-year history, a total of 104 pilot research projects have been funded, 67 of which were performed at UM, and 37 of which were performed at regional institutions. Over the reporting period (July 1, 2018 through June 30, 2023), the PPRTP funded 22 research projects in occupational health and safety, 10 (45%) of which were conducted at UM, and 12 (55%) of which were conducted at other universities in HHS Region V. Four projects are active in the current year (2022-23) and will be completed by June 30, 2023. Between 2018 and 2022, the 22 funded PPRT projects have resulted in 51 publications[1], and the awarding of 9 R01 or R21 grants. The most recent 22 projects have averaged nearly 2.5 publications each.

Final RPPR OVERALL Publication List

Adar, Sara D.

1. **Adar SD** and Pant P. Forward progress on characterizing the mortality burden of $PM_{2.5}$ for India. *Environ Health Perspect.* 2022. 130:9.
2. Filigrana P*, Batterman S, Levy J, Gauthier J, **Adar SD**. Health benefits from cleaner vehicles and increased active transportation in Seattle, Washington. *J Expo Sci Environ Epidiol. 2022.*
3. Pedde M*, Kloog I, Szpiro A, Dorman M, Shtein A, **Adar SD**. Estimating long-term $PM_{10-2.5}$ concentrations in six US cities using satellite-based data. *Atmos Env.* 2022. 272(1): 1187945.
   Filigrana P*, Milando C, Batterman S, Szpiro AA, **Adar SD**. Near-road exposures to traffic-generated PM2.5, NOx, and black carbon and risk of daily mortality: A case-crossover study. *Am J Epidemiol*. 2022. 191(1):63-74.
4. D'Souza J, Weuve J, Brook R, Kaufman JD, Evans DA, **Adar SD**. Long-term exposures to urban noise and blood pressure levels and control in older adults. *Hypertension. 2021. 78: 1801-1808.*
5. Weuve J, Bennett E, Ranker L, Powers S, Gianattasio KZ, Pedde M*, **Adar SD**, Yanosky JD, Power MC. Exposure to air pollution in relation to risk of dementia and related outcomes: An updated systematic review of the epidemiologic literature. *Environ Health Perspect*. 2021. 129(9).
6. Saenz J, **Adar SD**, Zhang Y, Wilkens J, Chattopadhyay A, Lee J, Wong R. Household Use of Polluting Cooking Fuels and Late-Life Cognitive Function: A Harmonized Analysis of India, Mexico, and China. *Env Internat.* 2021. 156:106722.
7. Shaffer RM*, Li G, **Adar SD**, Keene D, Latimer C, Crane P., Larson E., Carone M, Sheppard L. Fine particulate matter and markers of Alzheimer's Neuropathy in a Puget Sound cohort. *JAD.* 2021. 79(4): 1761-1773.
8. Weuve J, D'Souza J, Beck T, Evans DA, Kaufman JD, Mendes de Leon C, **Adar SD**. Long-term community noise exposure in relation to dementia, cognition, and cognitive decline in older adults. *Alzheimer's Dement.* 2021. 2020:00:1-9.
9. Nirel R, Levy I, **Adar SD**, Vakulenko-Lagun B, Peretz A, Golovner M, Dayan U. Concentration-response relationships between hourly particulate matter and ischemic events: A case-crossover analysis of effect modification by season and air-mass origin. *STOTEN.* 2021. 760: 143407.
10. Shaffer RM*, Blanco M, Li G, **Adar SD**, Carone M, Szpiro A, Kaufman J, Larson T, Larson E, Crane P., Sheppard L. Fine Particulate Matter and Dementia Incidence in the Adult Changes in Thought Study. *Environ Health Perspect*. 2021. 129(8).
11. Filigrana P*, Milando C, Batterman S, **Adar SD**. Spatiotemporal variations in traffic activity and their influence on air pollution levels in communities near highways. *Atmos Environ.* 2020. 242(1):117758.
12. Yue M, Kim JH, Evans CR, Kachman M, Erb-Downward JR, D'Souza JD, Foxman B, **Adar SD**, Curtis JL, Stringer KA. Measurement of short-chain fatty acids in non-fecal samples: Keep your assay above the water line. *Am J Resp Crit Care Med.* 2020. 202(4):610-612.
13. Erb-Downward JR, Falkowski NR, D'Souza JC, McCloskey LM, McDonald RA, Brown CA, Shedden K, Dickson RP, Freeman CM, Stringer KA, Foxman B, Huffnagle GB, Curtis JL, **Adar SD**. Critical relevance of stochastic effects on low bacterial biomass 16S analysis. *MBio.* 2020. 11(3):e00258-20.
14. Song L, Smith GS, **Adar SD**, Post WS, Guallar E, Navas-Acien A, Kaufman JD, Jones M. Ambient air pollution as a mediator in the pathway linking race/ethnicity to blood pressure elevation: the multi-ethnic study of atherosclerosis (MESA). *Env Res.* 2020. 180:108776.
15. Seith R*, Langeland A, Nambunmee K, **Adar SD**, Neitzel R. Self-reported health and heavy metal body burden in an electronic waste recycling community in Kalasin, Thailand. *J Env Occ Med.* 2019. 61(11):905-909.

16. Shaffer RM*, Sheppard L, Peskind ER, Zhang J, **Adar SD**, Li G. Fine particulate matter exposures and cerebrospinal fluid markers of vascular injury. *J Alz Dis.* 2019. 71(3):1015-1025.
17. Wang M, Barr RG, Hoffman EA, Madrigano J, Aaron CP, Sampson PD, Sheppard L, **Adar SD**, Vedal S, Kaufman JD. Long-term exposure to air pollution, change in quantitatively assessed emphysema on computed tomography, and lung function decline in the MESA Air and Lung Studies. *JAMA*. 2019.
18. Maestas MM, Brook RD, Ziemba RA, Li F, Crane RC, Bard RL, Spino C, **Adar SD**, Morishita M. Reduction of personal $PM_{2.5}$ exposures via indoor air filtration systems in Detroit: An intervention study. *J Exp Sci Environ Epidemiol.* 2019. 29:484-490.
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