NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

ANNUAL REPORT OF FISCAL YEAR 2023

Prepared by the Office of Extramural Coordination & Special Projects
National Institute for Occupational Safety and Health

U.S. Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

DISCLAIMER

Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC). In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

GET MORE INFORMATION

Find NIOSH products and get answers to workplace safety and health questions:

1-800-CDC-INFO (1-800-232-4636) | TTY: 1-888-232-6348

CDC/NIOSH INFO: cdc.gov/info | cdc.gov/niosh

Monthly NIOSH eNews: cdc.gov/niosh/eNews

SUGGESTED CITATION

NIOSH [2025]. NIOSH extramural research and training program: annual report of fiscal year 2023. By Coombs NC, Grandillo P, Castillo DN. Atlanta, GA: U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2026-100.

November 2025

NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

ANNUAL REPORT OF FISCAL YEAR 2023

Prepared by the Office of Extramural Coordination & Special Projects
National Institute for Occupational Safety and Health

Nicholas C. Coombs, PhD, MSTAT; Peter Grandillo, MBA; and Dawn N. Castillo, MPH

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

This page intentionally left blank.

FOREWORD

I am pleased to share with you the fiscal year (FY) 2023 annual report on the National Institute for Occupational Safety and Health (NIOSH) Extramural Research and Training Program. NIOSH aims to lead and support national occupational safety and health research and training programs and reduce work-related injuries and illnesses through a diversified portfolio of high-quality extramural research, education, and training. The data in this report reflect the achievements of the extramural community of researchers supported by NIOSH and the Office of Extramural Coordination & Special Projects (OECSP).

In Section II of this report, we report how NIOSH invested in our multidisciplinary centers, investigator-initiated research projects, and cooperative research agreements. We also report on our training project grants, state Occupational Safety and Health (OSH) surveillance programs, and small business innovation research. We include links to the NIOSH website throughout the report for direct access to additional data and information.

Section III describes the public health relevance and accomplishments of our varied and multidisciplinary portfolios with program highlights from FY 2023. Section IV is dedicated to the World Trade Center Health Program's extramural portfolio of cooperative agreements, describing the breadth, productivity, and impact of this program.

"I commend NIOSH extramural recipients for their outstanding science and training that enhance the safety, health, and well-being of the U.S. workforce, contributing to a stronger economy."

Safe, healthy workers are essential for a productive workforce. The NIOSH Extramural Research and Training Program is key to advancing occupational safety and health knowledge and applying it in practice, benefiting both workers and the economy.

John Howard, MD, Director,
National Institute for Occupational Safety and Health,
Centers for Disease Control and Prevention

AT-A-GLANCE: FY 2023 EXTRAMURAL AWARDS

In FY 2023, which spanned from October 1, 2022, through September 30, 2023, the National Institute for Occupational Safety and Health (NIOSH) funded 163 extramural awards totaling $107,453,055 for extramural research and training. Total funding for FY 2023 was 0.6% higher than in FY 2022 when 166 extramural awards totaled $106,799,670. You can find more information on annual extramural funding at Extramural Programs. This year's funding included the following:

63% Multidisciplinary Centers

12% Investigator-initiated Research

16% Cooperative Research Agreements

7% Specialty Training Programs

2% Small Business Innovation Research

Summary of all awards by type of funding, FY 2023

Award Category	Award Mechanism	Number of Awards	Funding
Multidisciplinary Centers		41	$67,636,616
Education and Research Centers	Training Grant (T42)	18	$30,789,403
Centers for Agricultural Safety and Health	Cooperative Research Agreement (U54)	12	$18,530,931
National Center for Construction Safety and Health Research and Translation	Cooperative Research Agreement (U60)	1	$5,750,000
Centers of Excellence for Total Worker Health®	Cooperative Research Agreement (U19)	10	$12,566,282
Investigator-initiated Research Grants		51	$13,424,569
Research Grants	Investigator-initiated (R01, R03, R21, R13, U13)	44	$12,672,076
Career Developmental Research	Mentored Career Scientist (K01)	7	$752,493
Cooperative Research Agreements		34	$17,302,842
State Occupational Safety and Health Surveillance program	Cooperative Research Agreement (U60)	23	$7,374,972
Occupational Safety & Health Surveillance Collaboration, Education & Translation	Cooperative Research Agreement (U24)	1	$275,000
National Mesothelioma Virtual Bank	Cooperative Research Agreement (U24)	1	$1,079,229
Commercial Fishing Occupational Safety Research*	Cooperative Research Agreement (U01)	6	$3,736,352
Mining and Safety Research†	Cooperative Research Agreement (U60)	3	$4,837,289
Specialty Training Programs		32	$7,238,725
Training Project Grants	Training Grant (T03)	27	$4,822,879
Miner Safety and Health Training Program	Cooperative Research Agreement (U60)	2	$485,938
Commercial Fishing Occupational Safety Training*	Training Grant (T03)	3	$1,929,908
Small Business Innovation Research		5	$1,850,303
Small Business Innovation Research	Phase I (R43) & Phase II (R44)	5	$1,850,303
Total Extramural Funding		**163**	**$107,453,055**

Note: This summary of awards by funding type does not include information for the World Trade Center Health Program; these data are shown in Section IV of this report.

* During FY 2023, no financial obligations were made toward the six Commercial Fishing Research Occupational Safety Research cooperative agreements and the three Commercial Fishing Occupational Safety Training grants. Because these projects were awarded for a single 36-month budget period in FY 2022, they remained active in FY 2023.

†Mining Safety and Health Research includes (1) Underground Mine Evacuation Technology and Human Factors Research and (2) NIOSH Robotics and Intelligent Mining Technology and Workplace Safety Research

In addition to extramural research and training, the NIOSH Office of Extramural Coordination & Special Projects (OECSP) manages the extramural activities of the World Trade Center (WTC) Health Program. This extramural portfolio includes the WTC Health Registry and research projects. Data for the WTC Health Program for 2011–2023 are in Section IV of this report, separate from all other extramural data. The total research funding for the WTC Health Registry and its 123 research projects was $255.3 million for 2011–2023. In FY 2023, that figure was $23.7 million for the WTC Health Registry and 39 research projects. This compares to FY 2022 funding of $23.6 million for the WTC Health Registry and 32 research projects.

In FY 2023, NIOSH extramural researchers wrote 510 peer-reviewed articles published in 212 journals. Education and Research Centers (T42) published the most articles (n=258), followed by investigator-initiated (R01, R03, R13, R21, R25, and K01) research (n=62). These articles appeared most often in the Journal of Agromedicine (n=33), followed by the Journal of Occupational and Environmental Medicine (n=20), and the International Journal of Environmental Research and Public Health (n=18). Altmetrics data—which measure the extent to which the public is influenced by, exposed to, promotes, and engages with research online, in the media, and beyond—show the following:

Out of 510 extramural articles, 388 (76%) were collectively mentioned or cited 7,598 times in social media, media, research articles, policy documents, and other sources.

- Of the FY 2023 articles, 5% (24) were given an Altmetrics Attention score of over 100, as scored by Altmetric. This score is reserved for research articles that receive a considerable amount of attention.
- Of the FY 2023 articles, 388 (76%) were mentioned or cited 7,598 times in various ways: 5,862 from social media, 1,660 from news and blogs, 51 from policy and patents, 14 from academic sources, and 11 from other sources.

Section III has more information on publications and program successes from extramural research and training during FY 2023, including the following:

- The Centers for Agricultural Safety and Health responded to persistent and emerging hazards such as zoonotic disease, natural disasters, and mental health of farmers.
- The Education and Research Centers graduated more than 300 occupational safety and health professionals and provided regional and industry-specific outreach and consultation to more than 5,000 businesses.
- Scientists from multiple universities collaborated on a scientific literature review that identified protective actions that can be taken to improve the health of wildland firefighters.
- Researchers developed new technology to increase situational awareness and coordination during rescues of underground miners.
- A scientific article that found increases in patient safety when a policy was in place that limited the length of resident physician's work shifts received considerable attention across news and media outlets, and by scientists.

The above highlights do not include those from the WTC Health Program. For information on peer-reviewed publications and other outputs or products from the WTC Health Program, see Section IV of this report.

TABLE OF CONTENTS

ACKNOWLEDGMENTS

For significant contributions to previous annual reports that this current report is built from, the authors acknowledge the following NIOSH contributors:

William A. Robinson, PhD

Donjanea F. Williams, EdD

Sarah A. Felknor, DrPH

LIST OF ABBREVIATIONS

SECTOR PROGRAMS

ALL	All Sectors or Multiple Sectors
AFF	Agriculture, Forestry, and Fishing
CON	Construction
HSA	Healthcare and Social Assistance
MNF	Manufacturing
MIN	Mining
OGE	Oil and Gas Extraction
PSS	Public Safety
SRV	Services
TWU	Transportation, Warehousing, and Utilities
WRT	Wholesale and Retail Trade

CROSS-SECTOR PROGRAM

CRC	Cancer, Reproductive, Cardiovascular, and Other Chronic Disease Prevention
HLP	Hearing Loss Prevention
HWD	Healthy Work Design and Well-Being
IID	Immune, Infectious, and Dermal Disease Prevention
MUS	Musculoskeletal Health
RHP	Respiratory Health
TIP	Traumatic Injury Prevention

LIST OF FIGURES

LIST OF TABLES

I. NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

The National Institute for Occupational Safety and Health (NIOSH) Extramural Research and Training Programs involve a wide array of projects. These include multidisciplinary research and training centers, investigator-initiated research, mentored research scientist development awards, training project grants, and small business innovation research grants in occupational safety and health. NIOSH also supports cooperative agreements. These include state OSH surveillance programs and funding for mining safety and health research. NIOSH also funds a Commercial Fishing Occupational Safety Research and Training Program. Collectively, these efforts expand the breadth and depth of extramural research and training at NIOSH. Read more about these programs on the NIOSH Extramural Research and Training Highlights webpage.

The Office of Extramural Coordination & Special Projects (OECSP) oversees the peer review and program management of the extramural research and training program portfolios. The office also manages the extramural portfolio of cooperative agreements for the World Trade Center (WTC) Health Program. This portfolio includes the WTC Health Registry and research projects, which are discussed separately in Section IV of this report.

The National Institutes of Health (NIH) publishes NIOSH extramural funding opportunity announcements in the NIH Guide for Grants and Contracts. This information also appears in the Funding Opportunities listed on the NIOSH Extramural Research and Training Programs webpage. The Appendix of this report lists all the FY2023 NIOSH funding opportunity announcements. All applications for extramural funding are peer-reviewed for scientific merit and reviewed internally for programmatic relevance.

NATIONAL OCCUPATIONAL RESEARCH AGENDA

The National Occupational Research Agenda (NORA) is a partnership program to stimulate new research and improved workplace practices. Unveiled in 1996, NORA serves as a research framework for NIOSH and the nation. NORA identifies and speaks to the most pressing issues in work-related safety and health.

As a steward of NORA, NIOSH launched the third decade in FY 2017. The program consists of 10 industry sectors and 7 cross-sectors representing major occupational safety and health issues and outcomes. NORA partners develop broad strategic objectives for research in each of those sectors and cross-sectors. They then work on those areas through information sharing, partnerships, and enhancing dissemination and implementation of evidence-based practices.

NIOSH PROGRAM AREAS

NIOSH organizes its research portfolio according to the NORA framework, with 10 sector programs and 7 cross-sector programs. In addition, NIOSH has core and specialty program areas, which represent essential activities, mandates, special focus areas, and methods to use in research that support the sector and cross-sector programs. Research priorities are organized by program area and outlined in the NIOSH Strategic Plan for FY 2019–2026. These goals are used for the NIOSH extramural and intramural programs, except for those under the WTC Health Program. Table 1 provides links to more information about these program areas and research priorities.

Table 1. NIOSH program areas

NIOSH Sector Programs	
Agriculture, Forestry, and Fishing	Oil and Gas Extraction
Construction	Public Safety
Healthcare and Social Assistance	Services
Manufacturing	Transportation, Warehousing, and Utilities
Mining	Wholesale and Retail Trade
NIOSH Cross-sector Programs	
Cancer, Reproductive, Cardiovascular, and Other Chronic Disease Prevention	Musculoskeletal Health
Healthy Work Design and Well-Being	Respiratory Health
Hearing Loss Prevention	Traumatic Injury Prevention
Immune, Infectious, and Dermal Disease Prevention	
NIOSH Core and Specialty Programs	
Authoritative Recommendations	Nanotechnology Research Center
Center for Direct Reading and Sensor Technologies	National Center for Productive Aging and Work
Center for Maritime Safety and Health Studies	Occupational Health Equity
Center for Motor Vehicle Safety	Personal Protective Technology
Center for Occupational Robotics Research	Prevention through Design
Center for Work and Fatigue Research	Safe • Skilled • Ready Workforce
Center for Workers' Compensation Studies	Small Business Assistance
Emergency Preparedness and Response	Surveillance
Engineering Controls	Translation Research/ Implementation Science
Exposure Assessment	

II. NIOSH EXTRAMURAL PROGRAM PORTFOLIO AND METRICS

FUNDING DISTRIBUTION FY 2023

In FY 2023, NIOSH awarded $107,453,055 in extramural funding for 163 projects. Data for the WTC Health Program are reported separately in Section IV. Figure 1 shows the distribution of awards by activity for FY 2023. The majority (63%) of extramural funding went to multidisciplinary centers, followed by 16% for cooperative research agreements. Other investigator-initiated and career development research grants accounted for 12% of the FY 2023 portfolio, followed by specialty training programs (7%) and small business innovation research projects (2%).

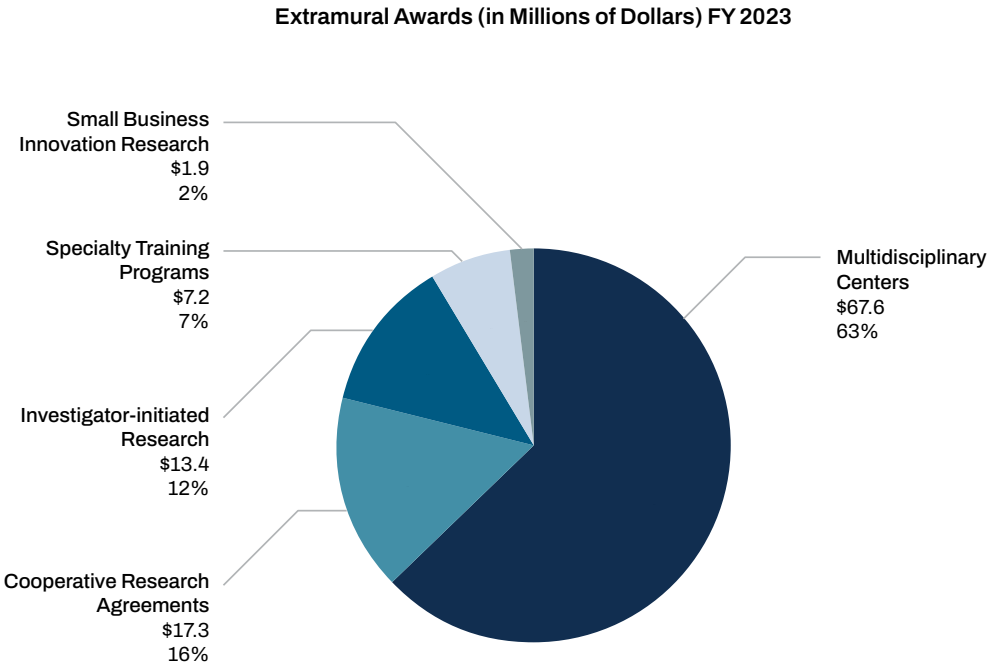


Figure 1. NIOSH extramural grant funding distribution, FY 2023

Table 2 summarizes the 163 awards that NIOSH funded (or supported) in FY 2023, which include 48 new awards and 115 continuing awards. Of these awards,

- 41 (25%) funded multidisciplinary research and training centers, which include Education and Research Centers (ERCs), Centers for Agricultural Safety and Health (Ag Centers), National Center for Construction Safety and Health Research and Translation (NCC), and Centers of Excellence for Total Worker Health®;
- 51 (31%) funded investigator-initiated research and career development;
- 34 (21%) funded cooperative research agreements;
- 32 (20%) funded specialty training programs; and
- 5 (3%) funded small business innovation research.

SUMMARY OF ALL AWARDS BY TYPE OF FUNDING

Table 2. Summary of all awards by type of funding, FY 2023

Award Category	Award Mechanism	Number of Awards	Funding
Multidisciplinary Centers		41	$67,636,616
Education and Research Centers	Training Grant (T42)	18	$30,789,403
Centers for Agricultural Safety and Health	Cooperative Research Agreement (U54)	12	$18,530,931
National Center for Construction Safety and Health Research and Translation	Cooperative Research Agreement (U60)	1	$5,750,000
Centers of Excellence for Total Worker Health®	Cooperative Research Agreement (U19)	10	$12,566,282
Investigator-initiated Research Grants		51	$13,424,569
Research Grants	Investigator-initiated (R01, R03, R21, R13, U13)	44	$12,672,076
Career Developmental Research	Mentored Career Scientist (K01)	7	$752,493
Cooperative Research Agreements		34	$17,302,842
State Occupational Safety and Health Surveillance program	Cooperative Research Agreement (U60)	23	$7,374,972
Occupational Safety & Health Surveillance Collaboration, Education & Translation	Cooperative Research Agreement (U24)	1	$275,000
National Mesothelioma Virtual Bank	Cooperative Research Agreement (U24)	1	$1,079,229
Commercial Fishing Occupational Safety Research*	Cooperative Research Agreement (U01)	6	$3,736,352
Mining and Safety Research†	Cooperative Research Agreement (U60)	3	$4,837,289
Specialty Training Programs		32	$7,238,725
Training Project Grants	Training Grant (T03)	27	$4,822,879
Miner Safety and Health Training Program	Cooperative Research Agreement (U60)	2	$485,938
Commercial Fishing Occupational Safety Training*	Training Grant (T03)	3	$1,929,908
Small Business Innovation Research		5	$1,850,303
Small Business Innovation Research	Phase I (R43) & Phase II (R44)	5	$1,850,303
Total Extramural Funding		**163**	**$107,453,055**

Note: This summary of awards by funding type does not include information for the World Trade Center Health Program; these data are shown in Section IV of this report.

* During FY 2023, no financial obligations were made toward the six Commercial Fishing Research Occupational Safety Research cooperative agreements and the three Commercial Fishing Occupational Safety Training grants. Because these projects were awarded for a single 36-month budget period in FY 2022, they remained active in FY 2023.

†Mining Safety and Health Research includes (1) Underground Mine Evacuation Technology and Human Factors Research and (2) NIOSH Robotics and Intelligent Mining Technology and Workplace Safety Research

EXTRAMURAL RESEARCH PORTFOLIO FY 2023

NIOSH extramural research includes multidisciplinary centers, investigator-initiated research, and cooperative agreements. Descriptions of these NIOSH extramural research awards follow:

Multidisciplinary Centers

NIOSH funds targeted research and outreach activities through multidisciplinary centers, which focus on high-risk industries that contribute disproportionately to work-related injury and illness in the United States. A variety of grant mechanisms, including cooperative research agreements and center training grants, fund these centers. The Ag Centers and NCC perform critical research into the many safety and health hazards in agriculture and construction.

A national network of ERCs carries out multidisciplinary education and research training activities. These university-based centers offer graduate and postgraduate training in the core and allied fields of occupational safety and health. Along with degree training, ERCs deliver continuing education and outreach to the occupational safety and health community throughout the federal health region they serve.

The Centers of Excellence for Total Worker Health (TWH) conduct research on TWH concepts. TWH advances the overall safety, health, and well-being of the U.S. workforce. The centers achieve this through a broad range of multidisciplinary research activities, including intervention-focused studies, outreach initiatives, educational programs, and evaluation efforts. The centers are hubs for TWH-related research and practice that build the scientific evidence base to develop new solutions for complex occupational safety and health problems. Their research examines the integration of occupational safety and health protection with workplace policies, programs, and practices to advance worker safety, health, and well-being.

NIOSH awarded approximately $67.6 million to 41 multidisciplinary centers in FY 2023 (see Figure 2). Note data in this figure are rounded to the nearest tenth.

Section III describes each of these center portfolios and provides highlights.

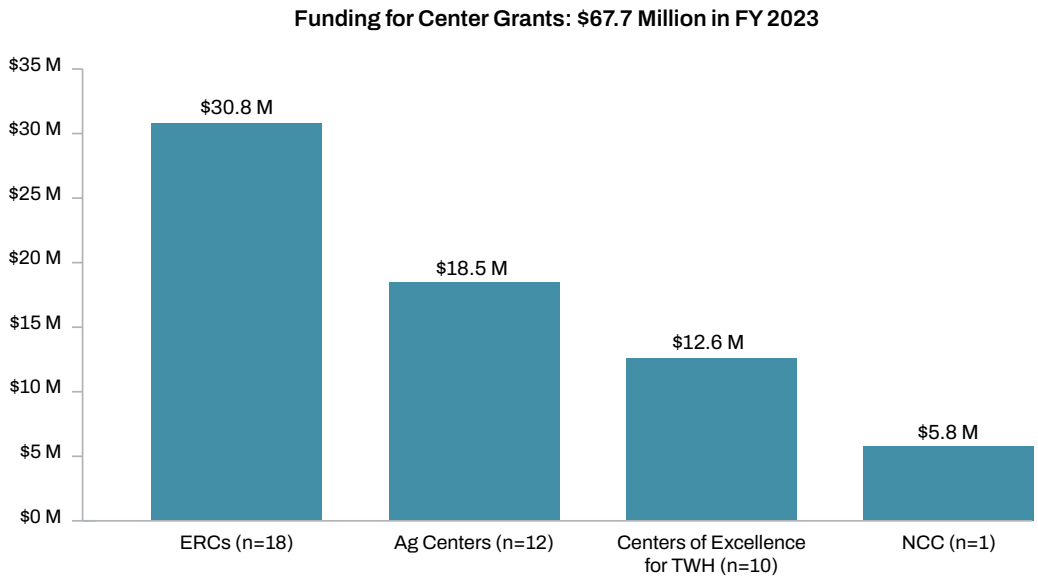


Figure 2. Multidisciplinary center awards, FY 2023

Investigator-initiated Research

NIOSH awarded $13.4 million to new and continuing research projects, mentored scientist grants, and conference grants in FY 2023 (see Table 3). Section III describes investigator-initiated research outputs.

Research Grants

Through its funding awards for investigator-initiated research, the NIOSH extramural research program supports relevant, quality scientific investigations that aim to help reduce job-related injuries and illnesses. These awards include:

- Large occupational safety and health research projects (R01)
- Small occupational safety and health research grants (R03)
- Exploratory occupational safety and health research grants (R21)
- Mentored scientist grants (K01)

Conference Grants

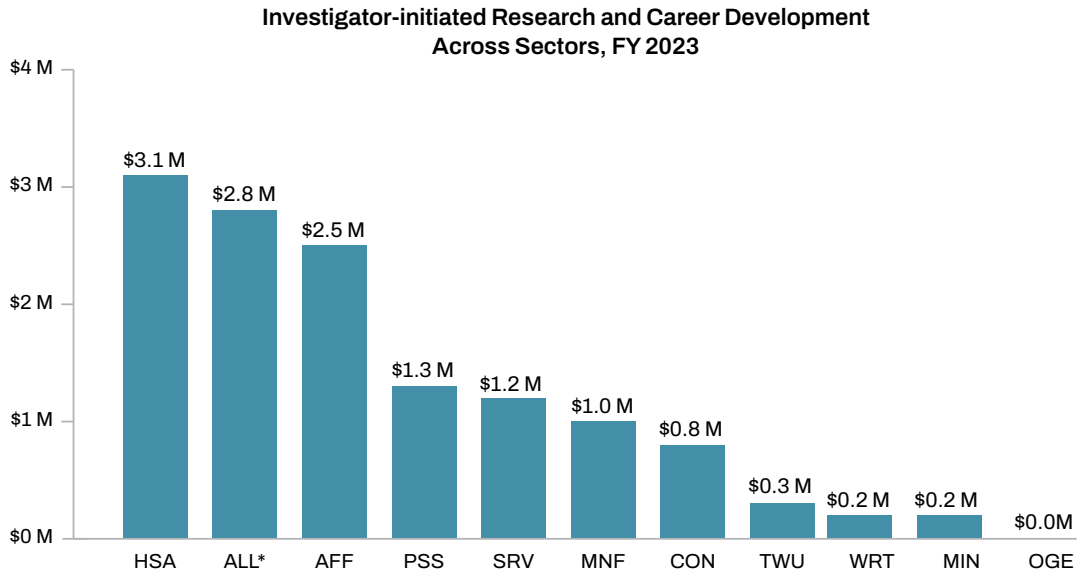
NIOSH values quality scientific meetings, which often result in new information to help prevent injuries, illnesses, and fatalities caused by workplace hazards. NIOSH awards conference grants under research grant (R13) and cooperative agreement (U13) mechanisms. In FY 2023, NIOSH funded one U13 cooperative agreement conference grant (see Table 3).

Table 3. Investigator-initiated research and conference grant funding, FY 2023

Grant Type	New Awards	New Funding	Continuing Awards	Continuing Funding	Total Funding
R01	5	$2,970,252	10	$5,349,344	$8,319,596
R21	11	$2,386,295	6	$1,235,109	$3,621,404
K01	3	$320,493	4	$432,000	$752,493
R03	6	$456,508	2	$154,624	$611,132
R13	0	$0	2	$39,944	$39,944
U13	1	$30,000	1	$50,000	$80,000
Total	**26**	**$6,163,548**	**25**	**$7,261,021**	**$13,424,569**

Extramural Research Activity by Industry Sector

NIOSH has research programs for each of the 10 industry sectors of NORA. Figure 3 shows FY 2023 funding for investigator-initiated research and career development research across the sectors. Extramural research in FY 2023 took place across all NIOSH sector program areas except Oil and Gas Extraction (OGE). Healthcare and Social Assistance (HSA), All Sectors* (ALL), and Agriculture, Forestry, and Fishing (AFF) received the most funding.



*Shows projects that contribute to advancing all or most of the NIOSH sector programs.

Figure 3. Research funding by sector program, FY 2023

EXTRAMURAL RESEARCH ACTIVITY BY CROSS-SECTORS

NIOSH has research programs for each the 7 cross-sectors of NORA. Figure 4 shows FY 2023 funding for investigator-initiated research and career development research across the cross-sectors. Extramural research in FY 2023 took place across all NIOSH cross-sector program areas, except Oil and Gas Extraction (OGE). Healthy Workplace Design and Well-Being (HWD) received the most funding, followed by Traumatic Injury Prevention (TIP), Respiratory Health (RHP).

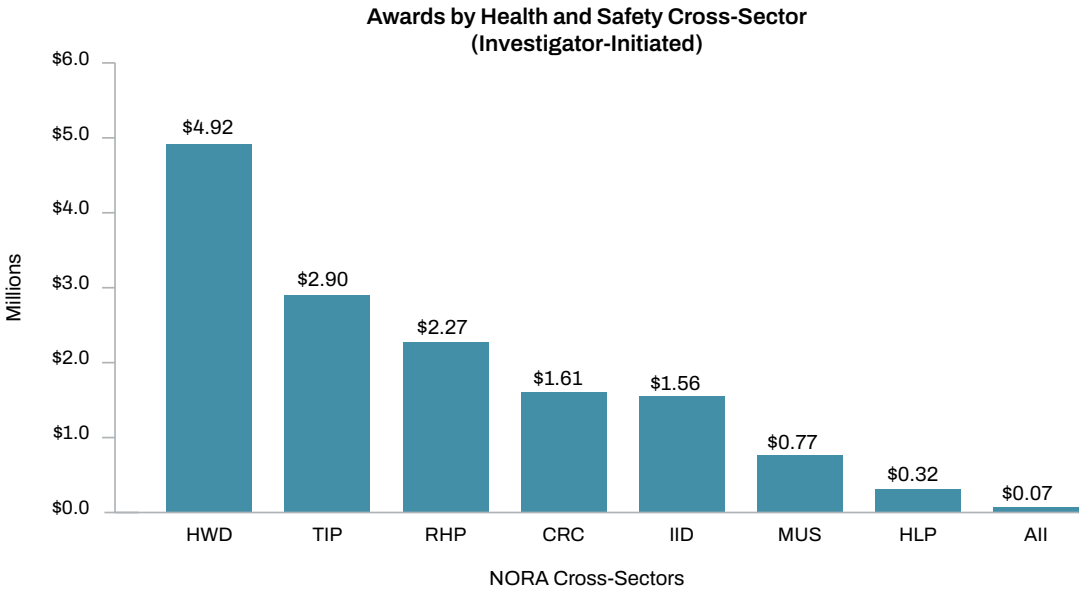


Figure 4. Funding for investigator-initiated research and career development research across the cross-sectors, FY2023.

Cooperative Agreements

NIOSH uses cooperative agreements to partner with state health departments, universities, labor unions, and nonprofit organizations in a variety of surveillance and research opportunities. NIOSH funds a broad array of cooperative agreements to develop knowledge for preventing work-related diseases, injury, and death.

Unlike grants, which are conducted independently of the sponsoring agency, cooperative agreements combine the knowledge of federal and nonfederal researchers to achieve public health efforts that would not otherwise occur. A cooperative agreement requires a clear need for NIOSH Program staff to contribute to the proposed project.

Cooperative research agreements funded in FY 2023 totaled $17.3 million. These included long-standing state OSH surveillance programs and funding for Occupational Safety and Health Surveillance Collaboration, Education, and Translation; Mining Safety and Health Research; Commercial Fishing Occupational Safety Research; and the National Mesothelioma Virtual Bank. Figure 5 shows how NIOSH distributed funds and how many cooperative research agreements received funding. Note data in this figure are rounded to the nearest tenth.

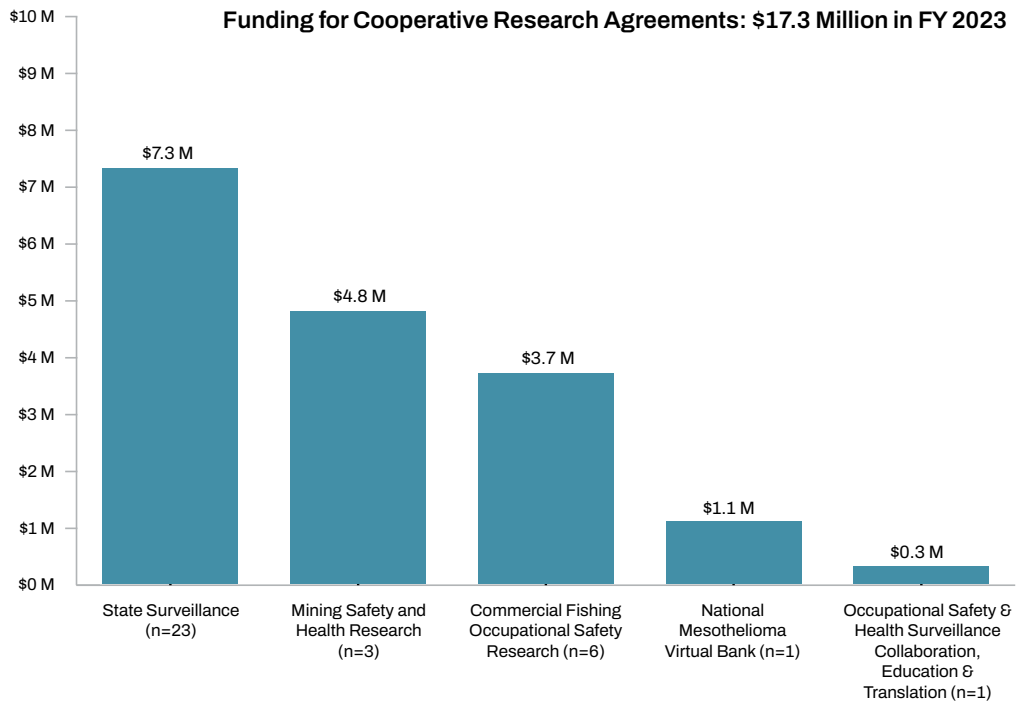


Figure 5. Cooperative agreements, FY 2023

State Occupational Safety and Health Surveillance Program

The State OSH Surveillance Program supports states and other eligible jurisdictions to develop their ability to monitor the extent and severity of work-related illnesses, injuries, exposures, and fatalities, and to identify workers and occupations at greatest risk. This program helps expand the role of states and other eligible jurisdictions in conducting in-depth surveillance and follow-up through investigations and interventions. In FY 2021, the program's new funding cycle began and included 23 award recipients, funded through 2026. These awards contribute to a national occupational safety and health surveillance program. The State OSH Surveillance Program webpage focuses on these state-based initiatives. Table 2 reports the total number and funding for all state surveillance awards for FY 2023.

Occupational Safety and Health Surveillance Collaboration, Education, and Translation

This cooperative agreement focuses on communication, education, and translational practice for occupational safety and health surveillance through a mix of approaches and strategies. The recipient of this funding is expected to lead the United States in promoting state, regional, and national collaboration, education, and translation (to include tribal nations, academic institutions, and other organizations). The goal is to increase capacity building for OSH programs and surveillance. The recipient will also conduct educational and outreach activities, such as organizing conferences and webinars, to promote surveillance data for action, and monitor statistical and other trends and their progress over time. They will also promote the use of multiple-source surveillance data; and leverage partnerships that will reduce work-related injuries, illnesses, exposures, and fatalities in the U.S. workforce.

In FY 2023, NIOSH funded one cooperative agreement related to occupational safety and health surveillance collaboration, education, and translation for $275,000 (Table 2). This award has a 5-year funding period.

National Mesothelioma Virtual Bank

The National Mesothelioma Virtual Bank (NMVB) for Translational Research advances translational research for the scientific community by collecting quality data and biospecimens, or human body materials, for mesothelioma research. Participating institutions share independent collections of tissues and other relevant information through this virtual registry and tissue bank. The research community uses these resources through a network of collaborators in the registry.

Developed in 2006, NMVB continues advancing biomedical research for malignant mesothelioma by expanding the collection of biospecimens, related data, and other information. NMVB gives researchers access to clinical data associated with a multitude of biospecimens and provides associated demographic data such as age, sex, race, occupational history, and other epidemiologic information. It also serves as a repository, providing a library of information on substances, chemical compounds, and other data related to mesothelioma that can be shared among investigators.

NMVB supports scientific discovery, identifies and develops early markers of the disease, improves detection, and helps develop effective treatments for mesothelioma. This work supports research that addresses the complex mechanisms and biological changes associated with mesothelioma and its disease progression. NMVB may ultimately help improve the quality of life of current and former workers who have malignant mesothelioma.

Commercial Fishing Occupational Safety Research and Training Program

Commercial fishing is one of the most dangerous occupations in the United States, and the hazards that fishermen face can vary widely by vessel and fishery. Research and training that address what works best in a specific fleet or region is critical to ensuring U.S. fishermen are getting the best possible occupational safety information and training. Despite some recent successes in reducing fatal work-related injuries within the commercial fishing industry, targeted safety research and training remains important.

The Commercial Fishing Occupational Safety Research and Training Program is a partnership between the U.S. Coast Guard and NIOSH that provides funding to qualified individuals in academia, members of nonprofit organizations, municipalities, and businesses involved in the U.S. commercial fishing industry. The funding supports research on improving the occupational safety of commercial fishermen and provides critical training for this high-risk occupation. In FY 2023, the Commercial Fishing Occupational Safety Research and Training Program paid up to 75% of an organization's costs. Each award ranged from $231,000 to $731,000 over a 3-year funding period.

In FY 2023, NIOSH and the U.S. Coast Guard had eight active research cooperative agreements and six training projects. No financial obligations were made to two of the research cooperative agreements

and three training grants during FY 2023. These projects received all funding in FY 2022 and remained active in FY 2023 using FY 2022 funds. You can find a list of all commercial fishing research project recipients at Commercial Fishing Occupational Safety Research and Training Program. Training projects are discussed at the end of the next section under Specialty Training Programs.

Mining Safety and Health Research

In FY 2023, NIOSH supported three cooperative agreement awards to address pressing needs in the Mining sector: two cooperative agreements for Underground Mine Evacuation Technologies and Human Factors and one cooperative agreement for Robotic and Intelligent Mining Technology and Workplace Safety Research.

The objective of the Underground Mine Evacuation Technologies and Human Factors cooperative agreements is to support universities with graduate programs in mining and explosives engineering. The aim is to develop and conduct research specifically focused on aspects of underground mine evacuation technologies and human factors related to mine emergencies. Research priorities include developing new wireless communication devices and methodologies; developing training, systems, and tools to facilitate miner self-escape; and continuing to improve the design of refuge alternatives.

NIOSH awarded two recipients to conduct this research in 2021 with a 4-year funding period. The Missouri University of Science and Technology received an award for "Research, Technological Innovations and Human Factors for Effective Miner Self-Escape from Underground Mine Emergencies." The New Mexico Institute of Mining and Technology received an award for the "Design and Demonstration of Intelligent Mine Evacuation and Mine Rescue System."

The objective of the Robotics and Intelligent Mining Technology and Workplace Safety Research cooperative agreement is to address research initiatives in automation, robotics, and intelligent mining systems to improve workplace safety and health in U.S. mining operations. This work aims to impact the following:

- Advance and implement human-centered design principles for automated equipment and their monitoring systems.
- Develop new methods, guidance, and best practices in change management, worker training and retention, technology integration, and safety evaluation.
- Use new methods and evaluation techniques for safe design that consider the entire mining operation as a system.
- Advance the availability of enabling technologies for assured autonomy including sensors, data fusion and processing, artificial intelligence, and systems for improved machine and operator situational awareness.
- Create new miner rescue and post-disaster surveillance technologies.

In FY 2023, the Missouri University of Science & Technology was awarded research funding for "Research and Technological Innovations in Automation, Robotics, and Intelligent Mining Systems for Transformative Improvements in Workplace Safety, Health, and Efficiencies." Funding will be nearly $4 million over a 4-year funding period.

Specialty Training Programs

NIOSH supports training in occupational safety and health through Training Project Grants (TPGs). The majority of TPGs are academic programs that support undergraduate, graduate, and postgraduate training. This includes the Association of Occupational and Environmental Clinics, which has a unique TPG through its Occupational Health Internship Program. Other TPGs reach targeted worker populations to meet their educational needs. For example, the Alaska Marine Education Association has a

grant focused on training a national network of fishing safety instructors in a Marine Safety Instructor training course to address the high fatality rates in commercial fishing.

The Emergency Responder Training Program is another TPG through the International Association of Fire Fighters (IAFF). This grant supports a comprehensive, nationwide hazardous materials training program for firefighters, paramedics, and other emergency responders across the United States.

The Miner Safety and Health Training Program—Western United States enhances the quality and complements the availability of health and safety training for mine workers in the United States. It aims to address the significant challenges of the mining industry. The Western Mining Safety and Health Training Resource Center provides these programs and activities at the University of Arizona, along with the Energy, Mining, and Construction Industry Safety Program at the Colorado School of Mines.

Three training projects are funded under the partnership between NIOSH and the U.S. Coast Guard through the Commercial Fishing Occupational Safety Research and Training Program. You can find more information on this program, including its research projects, under Cooperative Agreements.

Table 2 shows the number and funding of all specialty training grants (new and continuing) awarded in FY 2023.

Small Business Innovation Research

The Small Business Innovation Research (SBIR) program stimulates the private sector to innovate technology. The SBIR program also helps small businesses to commercially apply for federally supported research. In this process, they meet federal research needs as well as their own research and development needs.

The SBIR program funds small businesses in their early stages as they commercialize novel technologies for occupational safety and health. This competitive program helps small businesses join in federal research and development, produce life-saving technologies, and create jobs. The return on investment from federally funded research boosts the nation's economy and improves society.

NIOSH solicits Phase I and Phase II research proposals from science and technology-based firms that qualify as small businesses. Phase I awards focus on the feasibility, technical merit, and commercial potential of a research concept. Phase II proposals are limited to small businesses that complete their Phase I projects. In 2023, NIOSH funded three Phase 1 awards for funding periods less than a year and continued supporting two Phase II awards that continued into 2024. Table 2 shows awards and funding for all FY 2023 SBIR grants.

EXTRAMURAL RESEARCH TREND DATA

Extramural Research and Training Funding and Awards, FY 2014–2023

Figure 6 shows the total amount of extramural funding for each fiscal year from FY 2014 through FY 2023, along with the number of funded projects per year. These data include funding for all grants and cooperative agreements in the NIOSH extramural portfolio, including multidisciplinary centers, other cooperative agreements, investigator-initiated and career development research grants, and training grants. This information shows how NIOSH invested in its extramural research and training over time. More information on annual extramural funding and awards is available at Extramural Research and Training Program Annual Reports.

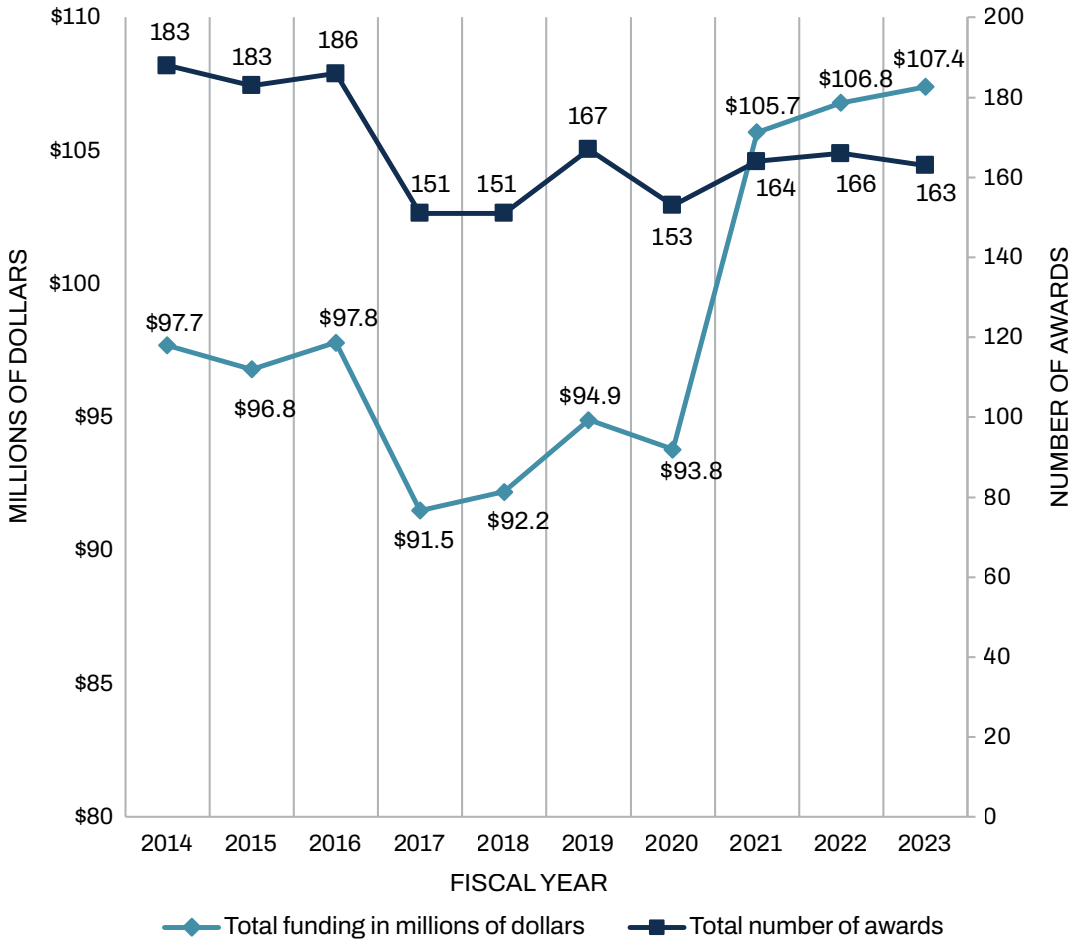


Figure 6. NIOSH extramural funding and awards, FY 2014–2023

Success Rates for Research Project Grants, FY 2014–2023

The success rate of reviewed new applications that receive funding in a fiscal year, calculated as a percentage, helps measure the viability of the research grants program. Success rates for new awards are calculated for the investigator-initiated research only, which includes the R01, R03, and R21 grant mechanisms. The success rate is a function of the number of applications received and the number of applications funded.

Figure 7 shows that there was a precipitous decline from FY 2014 through 2017 in the success rate for research project grants. The success rate generally increased in subsequent years to an 18% success rate in FY 2023. A similar trend is observed for each unique award mechanism (R01, R03, and R21) as shown in Figures 7-10. For FY 2014–2023, the mean annual number of applications was 160, the mean number of awards was 15, and the mean annual success rate was 10%.

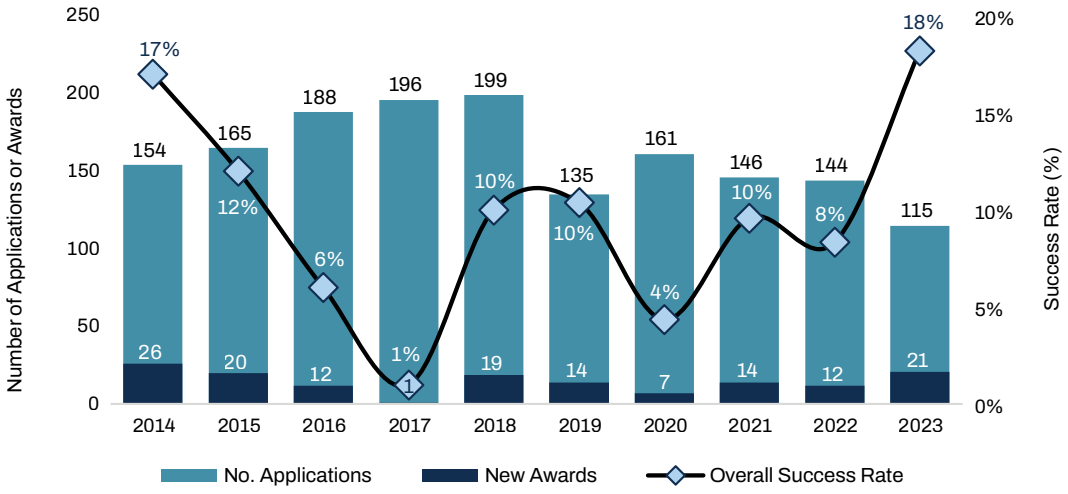


Figure 7. Overall success rates for research project grants (R01, R03, R21), FY 2014–2023

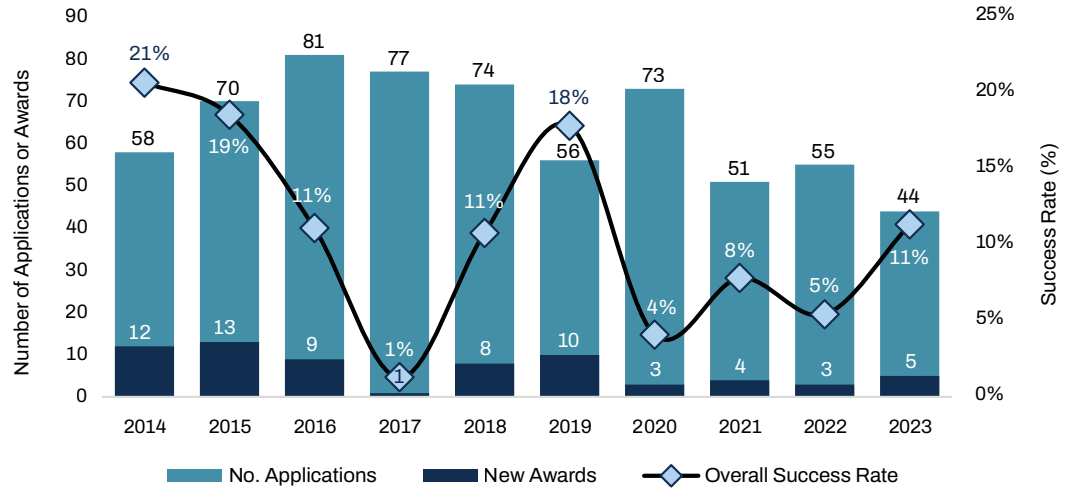


Figure 8. Success rates for R01 applications, FY 2014–2023

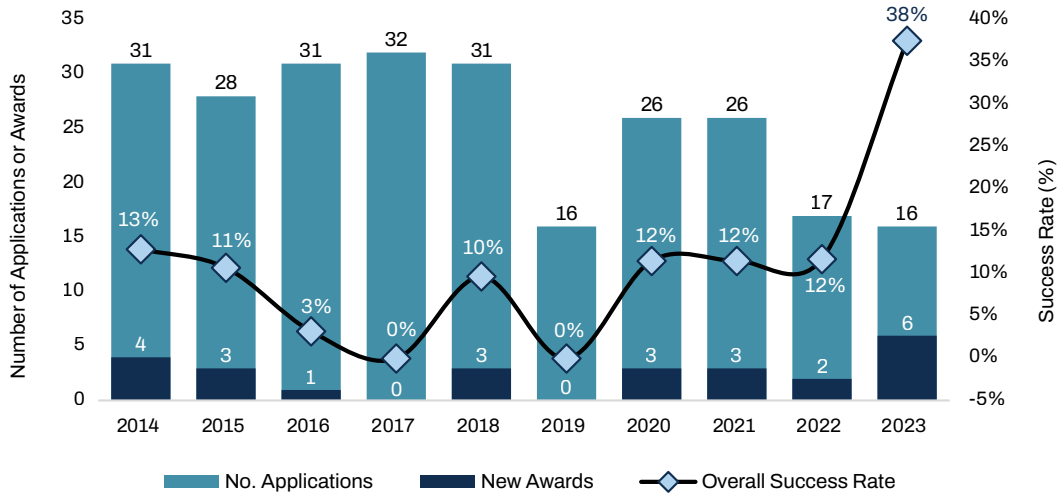


Figure 9. Success rates for R03 applications, FY 2014–2023

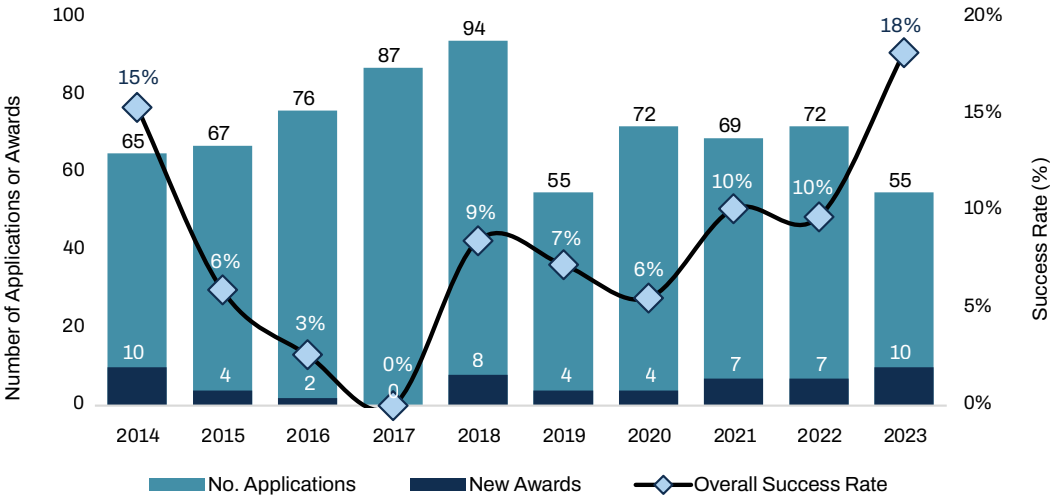


Figure 10. Success rates for R21 applications, FY 2014–2023

Table 4 shows the success rates for K01 applications, of which there have been far fewer applications than for investigator-initiated research grants.

Table 4. Success rates for K01 applications, FY 2021–2023

Fiscal Year	Number of Applications	Number of Awards	Success Rate
2021	10	3	30%
2022	8	2	25%
2023	4	3	75%

Note: NIOSH OECSP began capturing K01 application information in 2021.

III. FY 2023 EXTRAMURAL RESEARCH PROGRAM HIGHLIGHTS

Selected outputs or products, outcomes, and accomplishments of NIOSH-funded extramural research and training during FY 2023 are described in this section. The products include publications, reports, conference proceedings, presentations/posters, databases, tools, methods, guidelines, recommendations, education and training materials, inventions, and patents.

In FY 2023, extramural researchers wrote 510 articles published in 212 peer-reviewed journals, most frequently in the Journal of Agromedicine.

From October 1, 2022, through September 30, 2023, NIOSH-funded extramural research led to 510 peer-reviewed publications in 212 journals. Researchers published their NIOSH-funded studies in an array of journals related to occupational safety and health. Most often, they published in the Journal of Agromedicine (n=33), followed by the Journal of Occupational and Environmental Medicine (n=20), the International Journal of Environmental Research and Public Health (n=18), the American Journal of Industrial Medicine (n=14), Frontiers in Public Health (n=13), and Workplace Health and Safety (n=13). OECSP collected publications from the NIOSH Extramural Award Tracking (NEAT), the NIH RePORTER database, the NIOSHTIC-2 database, and the PubMed database. NIOSHTIC-2 is a searchable database of NIOSH publications, which includes grantee final reports and publications.

Out of 510 extramural articles, 388 (76%) were collectively mentioned or cited 7,598 times in social media, media, research articles, policy documents, and other sources.

In addition, altmetrics are data that are complementary to traditional, citation-based metrics and are an evolving measure of research outcomes. These data give insight into the extent that the public is influenced by, is exposed to, promotes, and engages with research online, in the media and beyond. Examples of altimetric data include the number of times a journal article is discussed in online research forums, blogs, and social media sites like X (formally Twitter), as well as in mainstream media coverage.

Program highlights or successes of extramural research and training are included in this part of the report.

Altmetrics also include data on the numbers of times an article has been viewed and cited in other research articles and policy documents. Across all 510 extramural articles, 388 (76%) were mentioned a total of 7,598 times. These mentions came most often on X and in news outlets; this is an average of 15 mentions per article. Twenty-four (5%) of the articles scored by altmetric.com were given an Altmetric Attention score of over 100. This score is reserved for research articles that receive a considerable amount of attention. Data from Altmetric were obtained October 24, 2024.

Table 5 includes descriptive statistics of the distribution of publications across each unique award category and mechanism. These data were collected by screening acknowledged grant numbers within each of the 510 NIOSH-funded publications for FY 2023. Note several publications reported multiple funding sources.

Table 5. Summary of all publications by type of funding FY 2023

Award Category	Award Mechanism	Number of Publications
Multidisciplinary Centers		
Education and Research Centers	Training Grant (T42)	265
Centers for Agricultural Safety and Health	Cooperative Research Agreement (U54)	93
Centers of Excellence for Total Worker Health	Cooperative Research Agreement (U19)	38
National Center for Construction Safety and Health Research and Translation	Cooperative Research Agreement (U60)	1
Investigator-initiated Research Grants		
Research Grants	Investigator-initiated (R01, R03, R13, R21, R25, U13)*	105
Career Developmental Research	Mentored Career Scientist (K01)	16
Award Category	**Award Mechanism**	**Number of Publications**
Cooperative Research Agreements		
State Occupational Safety and Health Surveillance Program	Cooperative Research Agreement (U60)	20
Occupational Safety & Health Surveillance Collaboration	Cooperative Research Agreement (U24)	1
Mining Safety and Health Research	Cooperative Research Agreement (U60)	3
Commercial Fishing Occupational Safety Research	Cooperative Research Agreement (U01)	5
National Mesothelioma Virtual Bank	Cooperative Research Agreement (U24)	11
Specialty Training Programs		
Training Project Grants	Training Grant (T03)	19
Miner Safety and Health Training Program	Cooperative Research Agreement (U60)	0
Commercial Fishing Occupational Safety Training	Training Grant (T03)	0
Small Business Innovation Research		
Small Business Innovation Research	Phase I (R43) & Phase II (R44)	0

Note: Several manuscripts acknowledged multiple funding sources, that is, a total of 590 awards were acknowledged across the 510 unique publications. Twelve publications acknowledged "the National Institute for Occupational Safety and Health" without a specific grant number. Number of publications is more specifically the measure of total unique award publications that account for several instances where a publication reported multiple funding sources within the same award category. Separate from this list included 2 publications for old Cooperative Agreements (U01)

*The breakdown of publications within investigator-initiated research grants included 78 from an R01 award, 8 from an R03 award, 2 from an R13 award, 15 from an R21 award, 2 from an R25 award, and 0 from a U13 award.

In addition to publications, the following sections describe other significant outputs or products and successes of NIOSH-funded extramural research supported by grant mechanisms during FY 2023.

MULTIDISCIPLINARY CENTERS

NIOSH funds multidisciplinary centers that focus on industries with an excessive share of job-related injury and illness. Various grant mechanisms, including cooperative research agreements and center training grants, fund these centers.

Education and Research Centers

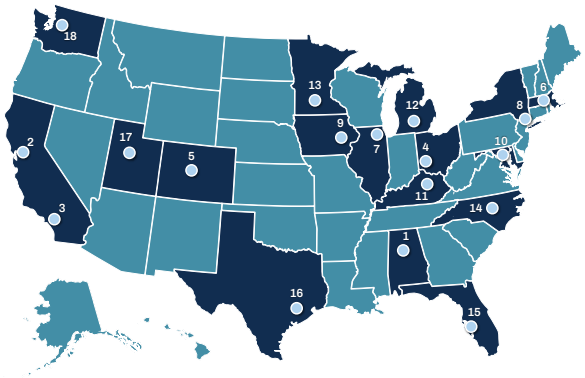
Overview

NIOSH is mandated to provide an adequate supply of qualified personnel to carry out the purposes of the Occupational Safety and Health Act (Public Law 91-596). The Education and Research Centers (ERCs) are one of the principal means for meeting this mandate. ERCs are academic institutions that provide high-quality interdisciplinary graduate and post-graduate training, research training, education, and outreach in the core occupational safety and health disciplines. These include industrial hygiene, occupational health nursing, occupational medicine residency, and occupational safety, as well as allied disciplines. Research and research training are integral components of ERCs, with ERC faculty and NIOSH trainees conducting research on issues related to the NIOSH Strategic Plan for FY 2019–2026 and emerging issues. ERCs serve as regional resources for industry, labor, government, and the public through training, research to practice, education, and outreach.

Public Health Relevance

NIOSH-funded ERCs serve a vital role in protecting the health and safety of the nation's workforce. ERCs improve occupational safety and health through education, research, and collaboration. They serve as regional, national, and global resources for business, labor, government, and the public.

NIOSH Research Centers



1. Deep South Center for Occupational Health and Safety (University of Alabama at Birmingham)
2. Northern California Education and Research Center (University of California, Berkeley)
3. Southern California Education and Research Center (University of California, Los Angeles)
4. University of Cincinnati Education and Research Center (University of Cincinnati)
5. Mountain and Plains Education and Research Center (University of Colorado Denver)
6. Harvard Education and Research Center (Harvard T.H. Chan School of Public Health)
7. Great Lakes Center for Occupational Health and Safety (University of Illinois at Chicago)
8. New York and New Jersey Education and Research Center (Icahn Mount Sinai School of Medicine)
9. Heartland Center for Occupational Health and Safety (University of Iowa)
10. Johns Hopkins Education and Research Center for Occupational Safety and Health (Johns Hopkins University)
11. Center Appalachian Regional Education and Research Center (University of Kentucky)
12. The University of Michigan Center for Occupational Health and Safety Engineering (University of Michigan)
13. Midwest Center for Occupational Health and Safety (University of Minnesota)
14. North Carolina Occupational Safety and Health Education and Research Center (University of North Carolina at Chapel Hill)
15. Sunshine Education and Research Center (University of South Florida)
16. Southwest Center for Occupational and Environmental Health (University of Texas Health and Science Center at Houston)
17. Rocky Mountain Center for Occupational and Environmental Health (University of Utah)
18. Northwest Center for Occupational Health and Safety (University of Washington)

ERCs support the development and enrichment of researchers and practitioners that are vital to improving and maintaining workplace health and safety. They also reduce the burden of preventable work-related injury, illness, and death by performing the following actions:

- Provide the necessary knowledge to the U.S. workforce.
- Develop major research advances .
- Provide regional and industry-specific outreach and consultation to more than 5,000 small-, medium-, and large-sized U.S. businesses annually.
- Serve as the primary knowledge source for public and government leaders for job-related safety issues without duplicating other government programs.

Research Outputs: Publications in FY 2023

ERC outputs are the products of research activities and include publications. From October 1, 2022, through September 30, 2023, the ERCs published 265 articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by ERCs in FY 2023.

Program Highlights FY 2023

Trainees, Graduates, and Employment of Graduates

In academic year 2022–2023, more than 300 students graduated from ERC programs with specialized training in industrial hygiene, occupational health nursing, occupational medicine, occupational safety, and allied occupational safety and health fields. Table 6 shows the number of students enrolled, graduates, and employment status during FY 2023.

One recent ERC graduate provided a testimonial of their experience:

> **"During my time as a [center trainee], I developed several of the skills necessary for a career as an Industrial Hygienist. I learned how to conduct personal and area sampling, evaluate ventilation systems to ensure they operate correctly, and design ventilation systems for a variety of industrial processes. During my training, I also learned how to analyze occupational exposure data using statistical software and how to leverage mathematical models to estimate occupational exposures to chemicals. In addition, I improved my skills in technical writing and delivering oral presentations. The training I received during this program is what helped me land an internship and entry-level position in the aerospace manufacturing sector."**

Table 6. ERC trainees, graduates, and employment, FY 2023

Program Area	Enrolled	Graduates	Employed or seeking occupational safety and health employment (%)
Industrial Hygiene	279	74	74 (100%)
Occupational Health Nursing	120	36	36 (100%)
Occupational Medicine	126*	44†	36 (82%)
Occupational Safety	322	142	141 (99%)
Allied Disciplines	358	80	74 (93%)
Total	1,205	376	339 (90%)

Note: Allied disciplines include the following interdisciplinary areas: Occupational Epidemiology, Occupational Injury Prevention Research, Transportation Safety (TRT Research), Occupational Biomechanics, Total Worker Health, Occupational Health Psychology, Agricultural Safety & Health, Human Factors & Ergonomics, Biomonitoring, Occupational Health Services Research, Occupational Health at the Human-animal Interface, Work and Health Graduate Certificate, Ergonomics, Climate and Worker Health and Safety, Health Physics, Mining Health and Safety, Occupational Athletic Training, and Health, Safety, and Environment.

*This number captures residents enrolled in postdoctoral training in occupational medicine.

†This number captures residents who have completed their residency in occupational medicine; 12 of the residents earned graduate degrees during this reporting period.

Table 7 shows the placement of FY 2023 graduates by program area and work setting. Graduates looking for occupational safety and health employment and not working outside their field were considered as remaining in the field.

Table 7. ERC graduate employment by work setting, FY 2023

Work Setting/ Program Area	Industrial Hygiene	Occupational Health Nursing	Occupational Medicine	Occupational Safety	Allied Disciplines	Total
Private Industry	37	6	5	115	19	182
Federal/State/Local Government	20	1	5	9	21	56
Academic Institution	8	4	5	7	13	37
Clinic/Hospital	2	19	17	0	2	40
Other Occupational Safety and Health Settings	0	0	0	1	3	4
Seeking Advanced Occupational Safety and Health Degree	2	1	2	9	8	22
Seeking Occupational Safety and Health Employment	5	5	2	0	8	20
Total	**74**	**36**	**36**	**141**	**74**	**361**

Continuing Education Outputs

Continuing education of occupational safety and health professionals is a required component for an ERC. Each year, NIOSH ERCs train thousands of professionals around the United States and globally through course offerings in the occupational safety and health core and allied disciplines. Table 8 shows the continuing education activity by discipline. In FY 2023, ERCs provided close to 300,000 person-hours of training to professionals through their offerings.

Table 8. Continuing education courses by discipline, FY 2023

Discipline	Number of Courses	Number of Trainees	Person-Hours of Training
Industrial Hygiene	144	5,537	45,527
Occupational Health Nursing	152	4,869	30,362
Occupational Medicine	149	4,466	15,473
Occupational Safety	734	18,889	138,077
Other Allied Disciplines	245	11,254	56,359
Total	**1,424**	**45,015**	**285,798**

Changes to an Interdisciplinary Occupational Health Course

Processes used by the Central Appalachian Regional Education and Research Center (CARERC) led to significant changes in their overall interdisciplinary training program. Changes to course preparation and design included (1) online mathematics and science review tutorials for students prior to course enrollment, (2) weekly interactive tutorials where faculty works directly with students, and (3) interactive study groups from other disciplines working together on problem sets and hazard evaluation reports.

All these efforts expanded the interactions between students and faculty. Scores on problem sets increased each year. In 2023, 21 students were enrolled in the course, holding a class average grade of 96%. This represented both the highest enrollment and highest average grade since CARERC's inception. Through regular quantitative- and qualitative-focused evaluations, student's course satisfaction increased corresponding with their performance.

Details:

- Website About Us | Central Appalachian Region ERC
- University Blurb | University of Kentucky College of Agriculture, Food, and Environment, Interdisciplinary Education, and Training

Per- and Polyfluoroalkyl Substances (PFAS) in Women 45–56 Years of Age: Multiple Results From the Study of Women's Health Across the Nation

Women become more susceptible to metabolic alterations during the menopausal transition. However, little is known about the potential role of PFAS in longitudinal changes in lipids among these midlife-aged women. In this study, investigators from the University of Michigan School of Public Health collaborated with U.S. researchers at the National Center for Environmental Health at CDC and international researchers in South Korea. Together, they examined the associations of serum PFAS concentrations of blood total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides in midlife-aged women.

The sample included 1,130 women ages 45–56 from the Study of Women's Health Across the Nation. Three distinct trajectories (low, middle, high) of total, LDL, and HDL cholesterol were identified. Results highlight concentrations of serum PFAS being positively associated with trajectories of total and LDL cholesterol, providing a line of evidence supporting adverse effects of PFAS on lipid homeostasis. Investigators published these findings in the Environmental Health Perspective Journal in August 2023. The paper has been cited 17 times.

An additional research question examined the extent to which racial/ethnic disparities in incident hypertension are explained by racial/ethnic differences in serum PFAS concentrations. During 11,722 person-years of follow-up, 470 participants developed incident hypertension (40.1 cases per 1,000 person-years). Black participants were at a greater risk of developing hypertension compared with White participants, with a relative survival rate of 0.58. This suggests possible differences based on race or ethnicity in hypertension onset. PFAS influenced the timing of this difference by 8.2%. These findings suggest differences in PFAS exposure may be an unrecognized modifiable risk factor that partially accounts for racial/ethnic disparities in timing of hypertension onset among midlife-aged women.

Details:

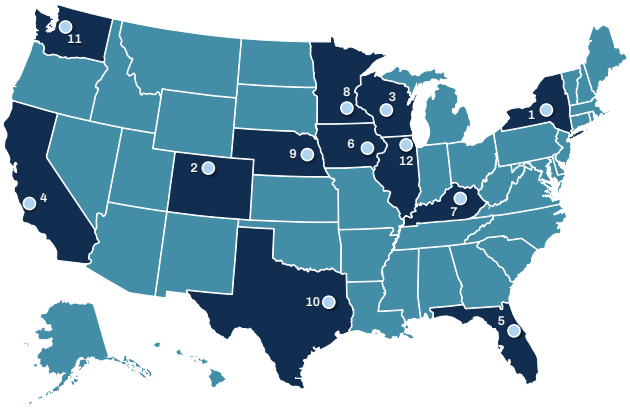
- Publication | Per- and Polyfluoroalkyl Substances (PFAS) and Lipid Trajectories in Women 45–56 Years of Age: The Study of Women's Health Across the Nation
- Publication | The Role of Exposure to Per- and Polyfluoroalkyl Substances in Racial/Ethnic Disparities in Hypertension: Results From the Study of Women's Health Across the Nation

Centers for Agricultural Safety and Health

Overview

The Centers for Agricultural Safety and Health (Ag Centers) were established in 1990 through cooperative agreements as part of the NIOSH Agricultural Safety and Health Initiative. They represent a major NIOSH effort to protect the safety and health of agriculture, forestry, and fishing (AgFF) workers and their families. These Ag Centers conduct research, education, and prevention projects to respond to the nation's pressing agricultural safety and health problems. Currently, 12 regional Ag Centers throughout the country work on regional safety and health issues, while also contributing to national outreach initiatives. NIOSH also supports the National Children's Center for Rural and Agricultural Safety and Health (Children's Center) within the National Farm Medicine Center in Marshfield, Wisconsin. With a national focus, the Children's Center strives to enhance the safety of all children exposed to hazards associated with agricultural work.

NIOSH Centers for Agricultural Safety and Health



1. Northeast Center for Occupational Health and Safety (Bassett Healthcare Network)
2. High Plains Intermountain Center for Agricultural Health and Safety (Colorado State University)
3. National Children's Center for Rural and Agricultural Health and Safety (National Farm Medicine Center)
4. Western Center for Agricultural Health and Safety (University of California, Davis)
5. Southeastern Costal Center for Agricultural Health and Safety (University of Florida)
6. Great Plains Center for Agricultural Health (University of Iowa)
7. Southeast Center for Agricultural Health and Injury Prevention (University of Kentucky)
8. Upper Midwest Agricultural Safety and Health Center (University of Minnesota)
9. Central States Center for Agricultural Safety and Health (University of Nebraska Medical Center)
10. Southwest Center for Agricultural Health, Injury Prevention and Education (University of Texas Health Science Center at Tyler)
11. Pacific Northwest Agricultural Safety and Health Center (University of Washington)
12. Great Lakes Center in Illinois

Public Health Relevance

In 1990, Congress established a national initiative in agricultural safety and health under Public Law 101-517. The intention of this initiative, "when sustained over a period of time, would result in a significant and measurable impact on … health effects among rural Americans." In response, NIOSH began funding Ag Centers in 1991. These centers strive to improve worker safety and health in the agriculture, forestry, and fishing industries—jobs that consistently rank among the most dangerous in the United States. The work of the Ag Centers has contributed to declines in injuries and deaths.

The Ag Centers' work spans the full research-to-practice continuum. First, they develop and conduct basic science to evaluate and quantify an issue. Researchers then transfer the results into engineering controls, educational outreach efforts, or policy changes aimed at preventing or mitigating a problem. The Ag Centers' research helps create and validate evidence-based approaches. However, the real impact occurs by applying these approaches through practical education, outreach, and prevention projects within their regions. Geographic diversity in agriculture, forestry, and fishing activities drives the need for regional engagement by the Ag Centers.

The Ag Centers made these significant contributions to public health in FY 2023:

- Integrating skill and knowledge from multiple disciplines, institutions, and community partners to solve complex problems.
- Providing a continuum of basic research through translation and outreach activities that turn findings into evidence-based prevention programs.
- Responding to the many persistent and emerging hazards such as zoonotic disease (transmitted from animals to people), natural disasters, and the ongoing mental health crisis that especially affects the agricultural workforce.
- Leading the NIOSH emergency response efforts for the Avian Influenza A/H5N1 (bird flu) virus.
- Contributing knowledge to agricultural industries in the fields of medicine, nursing, industrial hygiene, epidemiology, engineering, and education.

Research Outputs: Publications in FY 2023

From October 1, 2022, through September 30, 2023, Ag Centers published 93 articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by the Ag Centers in FY 2023.

Program Highlights in FY 2023

Lawn Mowing Safety Campaign

Mowing grass is one of the first jobs that youth are hired to do. This job is also particularly common for youth working on family farms. Annually, there are about 10,000 child/youth lawn mower injuries—about 5% result in amputations.

The National Children's Center for Rural and Agricultural Health and Safety formed the Childhood Agricultural Safety Network (CASN), an international coalition of organizations that work together to help keep children safe on the farm. These organizations represent the agricultural community, child injury prevention, and other related industry organizations. CASN led a lawn mowing safety campaign that solicited and reviewed existing lawn mower safety materials. They also designed "Are youth/you mow ready?" educational materials for adults and youth.

CASN curated a centralized source of 19 resources on youth lawn mower safety. In addition to visual and audio guidelines, they present a series of powerful stories that highlight previous childhood lawn mower-related injuries.

Details:

- Resource Directory | Cultivate Safety: Lawn Mowing
- YouTube video | Flammable Fuel Safety in Agriculture—The Legacy of Christopher Allsup
- Publication | Pediatric Lawn Mower-related Injuries and Contributing Factors for Bystander Injuries
- Reference Materials | Preventing Child Injury Toolkit

Ag Health 101

The Great Plains Center for Agricultural Health coordinated cross-center input with the Central States Center for Agricultural Safety and Health, Upper Midwest Agricultural Safety and Health, and the National Children's Center for Rural and Agricultural Health and Safety to develop an open-sourced training course. The "Ag Health 101" course introduces health hazards and research-based prevention practices to audiences such as healthcare providers, aides, and other advocates who work with agricultural workers.

The course contains 8 hours of audio material and innovative graphics organized into units that highlight heat illness prevention, sun safety, hearing protection, air quality and gas exposures, confined spaces, personal protective equipment, pesticides, falls on farms, and tractors.

Continuing Education (CEU) certificates are available after completing all units in the course. Through the grant cycle of Ag Health 101, almost 3,000 modules were completed, and 17 CEU certificates were issued.

Details: Training Course | AG Health 101

ATV Safety Research

All-terrain vehicle (ATV) crashes are among the leading causes of injury and death among youth in the agriculture industry, suspected to be exacerbated because many youth cannot effectively activate the vehicle's controls. Investigators at the University of California - Davis evaluated potential discrepancies between the required activation forces of the controls of 54 utility ATVs and the strength of male-and-female youth. Results from this study demonstrated a physical mismatch between the forces required to operate ATV controls and youth's strength, namely for turning the handlebar, pressing the footbrake, and pushing the ATV off if pinned underneath.

The main findings demonstrated several key considerations for ATV safety:

- The activation forces required to operate utility ATVs typically exceed the strength of most youth aged 6-20 years old.
- It may not be safe for youth to operate ATVs continuously for extended periods.
- The ability to activate ATVs' footbrake along with the ability to push off the ATV if pinned underneath are the most critical factors to determine if youth are capable of riding safely.
- Engine size and youth's age are poor indicators of youth-ATV fit.

These findings raise serious concerns about the ability of youth to safety operate ATVs in common use on U.S. farms. Parents/guardians may prevent injury by carefully evaluating the readiness of youth to ride ATVs, especially for occupational purposes.

Details: Publication | Forces required to operate controls on agricultural all-terrain vehicles: implications for youth

Motor Vehicle Safety Research

Transportation-related injuries are among the top contributors to the elevated rate of fatal injuries in the Agriculture, Forestry, and Fishing (AgFF) sector. However, traditional occupational injury surveillance systems often may not completely capture crashes involving farm vehicles and logging trucks, especially for non-fatal events. Investigators from Texas A&M developed an integrated database of AgFF-related motor-vehicle crashes for the southwest region of the United States, which included Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.

The structured crash data in each state included fields that allowed farm vehicles or equipment and logging trucks to be identified. Definitions and coding mechanisms varied by state but were able to be harmonized (made to be consistent or compatible). These data supported the construction of crash severity models and geospatial analyses using person-, vehicle-, and environmental-specific characteristics. Law enforcement provided additional details on crash causation in free-text narratives, which contained sufficient qualitative information to facilitate a mixed-methods approach to this research. Mixed-methods research integrates both quantitative and qualitative study methods to gain a more complete picture than using either method alone.

Crash records can help fill AgFF knowledge gaps in under-surveilled areas across the United States. This research further provides a bridge between traffic safety and occupational health to examine traffic

countermeasures, behavioral interventions, and other protective approaches to reducing transportation-related injuries among AgFF workers.

Details: Publication | Using motor vehicle crash records for injury surveillance and research in agriculture and forestry

National Center for Construction Safety and Health Research and Translation

Overview

CPWR—The Center for Construction Research and Training received a NIOSH cooperative agreement to be the National Center for Construction Safety and Health Research and Translation (NCC) for 2019–2024. CPWR received this funding through an extramural competition and has received NIOSH funding since 1990 through competitive processes. Along with its consortium of academic partners, CPWR studies safety and health risks, including their causes and solutions, that construction workers face on the job. The Center, with its construction community connections, leads in applied research and research to practice, making effective interventions available to the construction industry. Their research projects support NIOSH Construction Sector Program strategic goals and objectives as well as emerging issues. Furthermore, CPWR maintains a Data Center that serves as a leading source of detailed, reliable, and timely statistics and analysis about key issues in construction industry safety and health. Outputs within the Data Center include quarterly data reports and dozens of interactive data dashboards. CPWR also hosts a regular informational webinar series on current research, new efforts and trends in occupational safety and health, and training programs.

Public Health Relevance

CPWR has engaged in applied research for health and safety hazards, emerging issues research, construction industry data tracking, and research to practice. The Center has cultivated external partnerships for prevention, intervention, research, and research translation for protecting U.S. construction workers. An external evaluation of the NIOSH Construction Program in 2018 recognized CPWR for the value of its research translation-focused efforts in construction.

Research Outputs: Publications in FY 2023

CPWR outputs summarize construction research activities in a variety of communication forms, primarily other than peer-reviewed manuscripts. From October 1, 2022, through September 30, 2023, CPWR published one article in a peer-reviewed journal. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search.

Program Highlights in FY 2023

Prevention through Design: Perceptions Among Upstream Design Professionals and Project Owners

Prevention through Design (PtD) has not been rapidly adopted in the United States. To understand why, CPWR is researching attitudes and barriers to PtD adoption. In the project's first stage, investigators worked with Dodge Data and Analytics, one of the industry's leading data providers, to survey pre-construction professionals.

More than 300 architects and engineers completed the survey. Additionally, 10 semi-structured interviews were conducted to deploy a mixed methods approach. Survey findings were presented at an all-staff meeting of the OSHA Directorate of Construction in August 2022 and during a CPWR webinar on "Preventing Falls Through Improved Design" in March 2023. Hundreds of in-person and online participants attended these meetings.

Key construction stakeholders, such as manufacturers, institutions (e.g., universities and hospitals), and government agencies, can play a key role in encouraging and applying PtD. Efforts to conduct follow-up research with construction project stakeholders are ongoing. The goal is to collect information that will improve communication in the construction industry about the benefits of routinely applying PtD practices. CPWR investigators maintain an up-to-date annotated bibliography as an informational resource for researchers, practitioners, and the public.

Details: Annotated Bibliography | Topics in Construction Safety and Health – Prevention through Design

Nanomaterials in Construction

Researchers are identifying new uses of engineered nanomaterials (ENMs) in construction. To study ENMs, scientists apply industrial hygiene methods to evaluate exposure risks in controlled chambers during simulated tasks. They have created a comprehensive inventory of nano-enabled construction materials that is updated weekly. Figure 10 shows an infographic, published in Safety and Health Magazine, which defines nanomaterials for workers. Currently, this inventory includes ENMs in 897 construction products with 509 reference articles and materials. Project outputs were featured in several news articles listed below in Details.

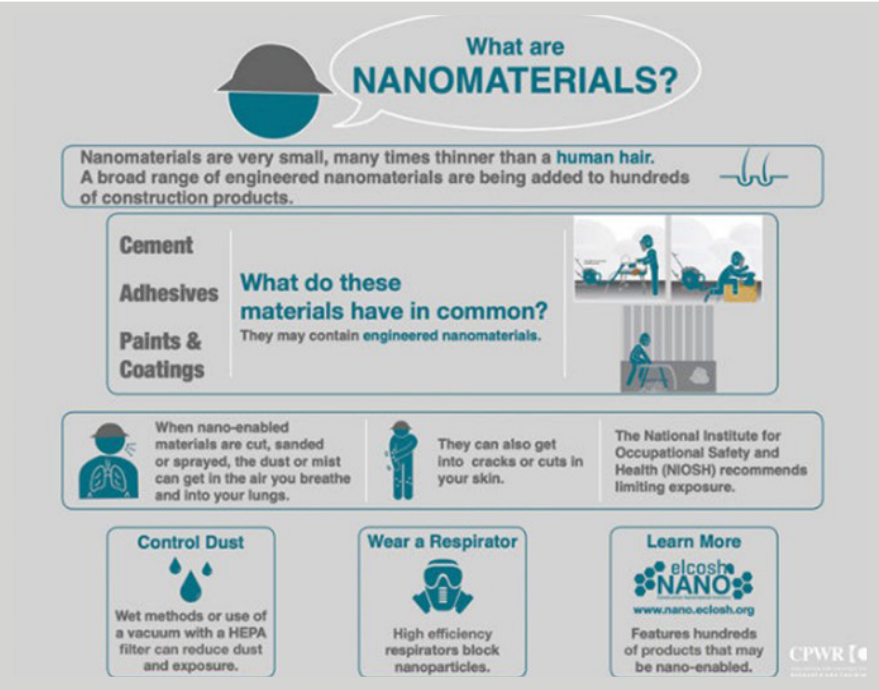


Figure 11. Nanomaterial infographic.
Image by CPWR

CRWR's work on nanomaterials has been cited over 80 times in peer-reviewed studies and other documents, including the Organization for Economic Co-operation and Development report: Moving Towards a Safe(r) Innovation Approach (SIA) for More Sustainable Nanomaterials and Nano-enabled Products.

Trainers who participated in the nanomaterial team's train-the-trainer sessions have used the customized training curricula to teach 820 construction workers across 49 classes. These training sessions highlight nanomaterial applications, health risks, exposures, and controls.

The nanomaterial team received the Randy Ogle/Paul Baron Award at the American Industrial Hygiene Conference and Expo in May 2022 in recognition of their study on silver nanoparticle exposure in the Journal of Occupational and Environmental Hygiene.

Details:

- Resources | Construction Nanomaterial Inventory
- News Article | Built the Bluebeam Blog
- News Article | Safety & Health Magazine
- News Article | Industrial Safety & Hygiene News

Communications, Outreach, and Evaluation

CPWR has maintained and significantly grown the CPWR, OSHA, and NIOSH Database and Outreach Resource (CONDOR). CONDOR is a resource developed for focused outreach on critical health and safety innovations, emerging issues, and new findings to those who need and can use these resources.

CONDOR includes contact information for thousands of construction contractors, government officials, health and safety professionals, university-based researchers, labor representatives, trade press, and others. At the start of the FY 2019 funding cycle, the database had 10,898 contacts. As of FY 2023, it had more than 25,900 contacts. This represents an 80% increase over 4 years, with a year remaining in the funding cycle. CPWR increased its capacity to reach key audiences, such as smaller employers, and expanded its ability to understand the interests of its audience through surveys, interviews, and website analytics. Figure 11 shows the total number of email subscribers and database contacts over the grant cycle.

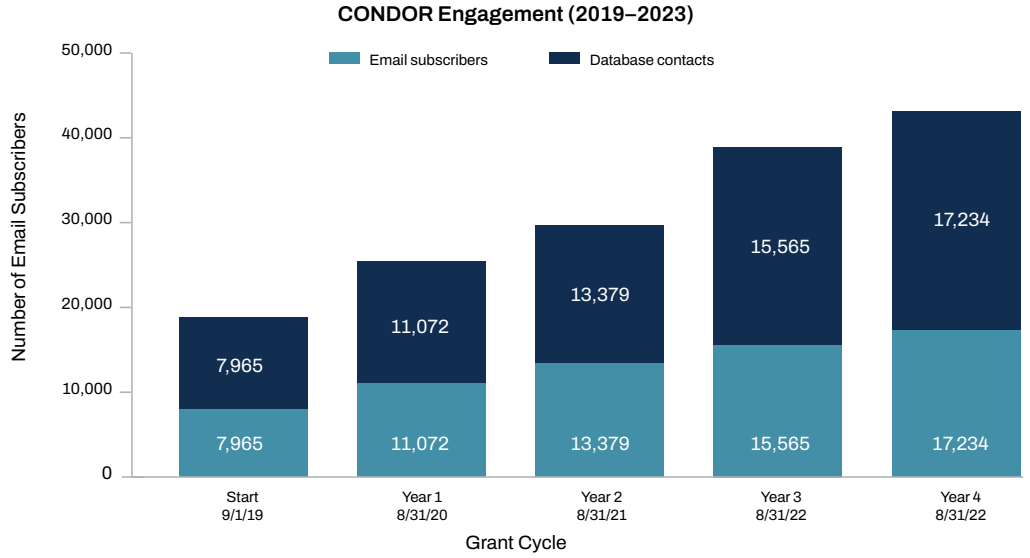


Figure 12. CPWR, OSHA, and NIOSH database and outreach resource (CONDOR) engagement, 2019–2023

Centers of Excellence for Total Worker Health®

Overview

In FY 2023, NIOSH funded 10 Centers of Excellence for Total Worker Health (TWH) throughout the United States to explore and research TWH-related concepts. This funding included new centers in California, Maryland, North Carolina, and Utah, along with existing centers in Colorado, Connecticut, Illinois, Iowa, Massachusetts, and Oregon. NIOSH defines TWH as policies, programs, and practices that combine protection from work-related safety and health hazards with the promotion of injury and illness prevention. This integrated strategy is designed to advance worker well-being and provide a hazard-free workplace for all workers.

The Centers of Excellence made important progress toward implementing TWH-related research and practice:

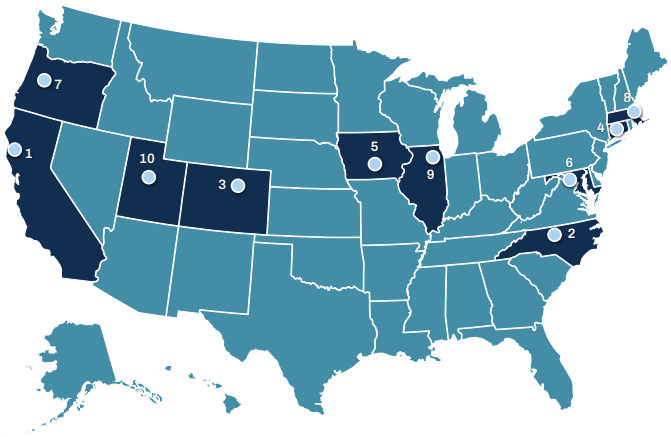
- Pilot testing promising workplace policies and programs.
- Developing and distributing best practices and tool kits for and to employers.
- Creating strategies to overcome barriers for adoption of work-based interventions to protect and promote worker safety, health, and well-being.
- Investigating costs and benefits associated with integrated programs.
- Promoting increased development and application of biological markers of stress, sleep, and depression to protect workers and improve worker health.
- Examining the relationships between workplace policies and practices and worker health outcomes.

Public Health Relevance

The Centers of Excellence develop and evaluate TWH interventions to improve safety, health, and well-being in high-risk industries that can reduce healthcare costs when adopted on a broad scale. The centers engaged in the following:

- Conduct multidisciplinary research on the effects and outcomes of policies, programs, and practices that combine work-related safety and health protection with injury and illness prevention to advance worker well-being.
- Develop and disseminate evidence-based research and recommendations for workplace programs, policies, and practices.
- Produce educational materials, outreach, and resources tailored to specific audiences and help them adopt or adapt strategies to protect the health of workers and improve worker well-being.
- Evaluate research outcomes to see how they impact job-related safety and health and reduce risks.

Centers of Excellence for Total Worker Health®



1. California Labor Laboratory (CALL Center)
2. Carolina Center for Healthy Work, Design and Worker Well-being
3. Center for Health, Work & Environment
4. Center for the Promotion of Health in the New England Workplace (CPH-NEW)
5. Healthier Workforce Center of the Midwest
6. Johns HOpkins P.O.E. *Total Worker Health®* Center in Mental Health (POE Center)
7. Oregon Healthy Workforce Center (OHWC)
8. The Harvard T.H. Chan School of Public Health Center for Work, Health & Well-being
9. UIC Center for Healthy Work
10. Utah Center for Promotion of Work Equity (U-POWER)

Research Outputs: Publications in FY 2023

From October 1, 2022, through September 30, 2023, the Centers of Excellence published 38 articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by TWH in FY 2023.

Program Highlights FY 2023

Thriving From Work Questionnaire

Researchers define the "Thriving from Work" concept as the state of positive mental, physical, and social functioning in which workers' experiences of their work and working conditions enable them to thrive in their overall lives. This functional state contributes to workers' ability to achieve their full potential at work, at home, and in the community. The purpose of this study was to develop an assessment-based questionnaire measuring the positive contribution that work can have on one's well-being both inside and outside of the workplace.

Harvard investigators developed the Thriving from Work Questionnaire using a qualitative and quantitative approach. The questionnaire appears to be a valid and reliable measure of work-related well-being in U.S. workers. The questionnaire is available in English, Spanish, Haitian Creole, and German. Validation studies for these non-English languages were also done in FY 2023. Researchers created a user manual to guide organizations in using these tools for assessing and improving mental health and well-being in the workplace.

This initiative emphasizes the importance of thriving workplaces as contributors to mental health and well-being. By measuring and improving group-level thriving, this study provides actionable insights for enhancing mental health outcomes across different workforces.

Details:

- Original Research Study | Thriving From Work Questionnaire: Dimensionality, Reliability, and Validity of the Long and Short Form Questionnaires
- Thriving from Work Questionnaire | Center for Work, Health, & Well-being

Supporting Workers with Mental Health and Substance Use Challenges

Mental health and substance use challenges were a key focus of multiple TWH Centers of Excellence in FY 2023. The Center for Health, Work & Environment in Colorado administered a regional recovery friendly workplace initiative. Working with other states and business leaders, the program was designed to help employers use best practices. Peer learning sessions and tailored advising were provided to 37 organizations. These sessions focused on reviewing policies, planning events, and training employees. Twenty organizations completed the Health Links Mental Health Module, demonstrating improved awareness of resources to support workers.

The Healthier Workforce Center of the Midwest hosted regional employers and practitioners to discuss methods to support employees affected by substance use disorders. Key topics included strategies for creating recovery friendly workplaces and leadership approaches for employees in recovery.

The Healthier Workforce Center of the Midwest also launched a suicide prevention campaign to share resources for construction, agriculture, and general industry workplaces. After this outreach, it was shown that 40% of workplaces that received campaign resources started developing plans to improve worker mental health. Improvements were often in the form of mental health first aid training, peer support programs, and mental health-focused policies. By FY 2023, over 1,600 people had learned about the campaign.

Details:

- Initiative | Colorado Recovery Friendly Workplace Initiative
- Recovery Friendly Workplace – Healthier Workforce Center of the Midwest
- Webinar | The Why and How of Recovery Friendly Workplaces
- Mental Health Modules | Health Links
- Suicide Prevention Campaign for the Workplace – Healthier Workforce Center of the Midwest

INVESTIGATOR-INITIATED RESEARCH

The NIOSH extramural research program supports relevant, high-quality scientific investigations that help reduce work-related injuries, illnesses, and fatalities. These awards include funding for research projects of varying size and scope, career development research, and support of conference grants.

Research Grants

Overview

The R01 funding mechanism focuses on developing an understanding of the risks and conditions associated with job-related injuries, illnesses, and fatalities. These projects also explore methods to reduce risks and prevent or lessen exposure to hazardous workplace conditions. The R03 funding mechanism supports research projects that can be completed in two years with limited resources, including pilot and feasibility studies, secondary analysis of existing data, and small, self-contained research projects. The R21 funding mechanism encourages research to explore new scientific ideas or develop new techniques, methods, model systems, tools, or other applications with the potential for significant impact on work-related safety and health. NIOSH awards conference and scientific meeting grants under two research grant mechanisms: R13 and U13. Both grants support high quality scientific conferences, and meetings relevant to the safety and health of workers, including symposia, seminars, and workshops.

The extramural research portfolio also includes mentored research scientist development awards that offer postdoctoral training for the next generation of occupational safety and health scientists. These highly competitive K01 awards give up to three years of funding and are designed to develop the skills and productivity of new research scientists as they transition between postdoctoral training and independent research.

Public Health Relevance

The mission of NIOSH is to develop new knowledge in the field of occupational safety and health and then transfer it to practice. The extramural research program advances this mission through its research. This work supports the processes for identifying workers at risk, developing methods for measuring hazard exposures, and detecting adverse health effects. The program also helps in determining the frequency of job-related hazards, increasing understanding of the causes of work-related diseases and injuries, and reducing or eliminating hazard exposures. Grantees share research results through different communication channels, including scientific meetings, conferences, and workshops.

Research Outputs: Publications in FY 2023

Investigator-initiated research outputs are the products of research activities and include publications. From October 1, 2022, through September 30, 2023, R01 grant-funded researchers published 78 articles in peer-reviewed journals. The numbers of peer-reviewed publications for the other investigator-initiated research mechanisms are 8 (R03), 2 (R13), 15 (R21), 15 (K01), and 2 (other). Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by investigator-initiated research in FY 2023.

Program Highlights FY 2023

Workplace Violence in Outpatient Physician Clinics (R01 Grant)

Principal Investigator: Lisa A. Pompeii

Institution: Baylor College of Medicine

Investigators from Baylor College of Medicine conducted the first NIOSH-funded study that examined workplace violence and prevention efforts in outpatient physician clinics. Little is known about workplace violence in these settings compared to hospitals. Surveys were administered to 159 clinic managers and 2,106 frontline clinic workers at outpatient physician clinics across the United States. Workplace violence consisted of criminal (Type 1), patient/family-perpetrated (Type 2), worker-on-worker (Type 3), and domestic violence spilling into the workplace (Type 4).

Frontline workers reported higher rates for all types of workplace violence, particularly in pediatrics where they reported twice as many Type 1 events and three times as many Type 2 events compared with managers. These differences are even more distinguished for Type 3 and 4 events, partially due to managers reporting very few workplace violence events.

Both clinic managers and frontline clinic workers indicated glaring gaps in prevention and response methods for WPV. Among all outpatient hospital clinics in the study,

- 48% do not have an alarm security system.
- 66% do not have a panic alarm system.
- 66% do not have surveillance in their parking area.
- 49% do not have surveillance in the patient entrance area.
- 42% do not have security guard presence.
- 40% do not have written WPV prevention policies.
- 66% have not received Crisis Prevention training.

These findings suggest that clinic managers may underestimate the prevalence of WPV. This study highlights the need for improved methods to capture and address workplace safety and health in outpatient clinics.

Details:

- Publication | Workplace Violence in Outpatient Physician Clinics: A Systematic Review
- Abstract | Workplace Violence in Outpatient Physician Clinics: A Systematic Review

National Improvements in Resident Physician-reported Patient Safety After Limiting First-year Resident Physicians' Extended Duration Work Shifts: A Pooled Analysis of Prospective Cohort Studies (R01 Grant)

Principal Investigator: Matthew D. Weaver

Institution: Brigham and Women's Hospital

In 2017, a policy that restricted first-year resident physicians in the United States to work more than 16 consecutive hours was rescinded. To explore the effects of this policy, investigators from the Brigham and Women's Hospital conducted a nationwide prospective cohort study to examine trends in resident physician-reported medical errors between time periods before (2002–2007) and after (2014–2017) this initial policy change.

Researchers found the following trends associated with the implementation of this policy:

- A 32% reduced risk of resident physician-reported significant medical errors.
- A 34% reduced risk of preventable adverse effects.
- A 63% reduced risk of medical errors resulting in patient death.

Dr. Weaver and colleagues published this work in the British Medical Journal Quality & Safety in February 2023. Since publication, the paper has been mentioned 757 times across news and media outlets and cited 25 times in other peer-reviewed publications.

Details: Publication | National Improvements in Resident Physician-reported Patient Safety After Limiting First-year Resident Physicians' Extended Duration Work Shifts: A Pooled Analysis of Prospective Cohort Studies

Coordination of Vehicle Lighting and Markings for Improved Worker Safety (R21 Grant)

Principal Investigator: Mark S. Rea

Institution: ICAHN School of Medicine at Mount Sinai

Emergency responders, highway maintenance personnel, utility workers, and others who work along roadways face an increased risk of being injured or killed by vehicle traffic. These workers use vehicles equipped with flashing emergency lights, special paint colors, and reflective markings to help drivers detect and identify them and avoid collision.

Investigators at the School of Medicine at Mount Sinai explored how the colors of emergency and service vehicles (markings and flashing lights) impact drivers' abilities to identify whether a roadside incident scene is an emergency or nonemergency. Laboratory studies showed that the colors of flashing lights are the most important factor. Participants reported being more likely to stop or slow down when they approach flashing red lights and when the vehicle colors and markings coordinated with the flashing lights. A subsequent field study was done to assess the practicality of applying the findings in real-world environments. The field study successfully showed the results to be feasible and consistent.

The results have important implications for the safety of workers along the roadway near service vehicles. Coordinating the colors of flashing lights with the vehicles and their markings can inform drivers about what they are approaching. With this information, drivers can maneuver their vehicles to avoid collisions. This study has been disseminated across a series of online videos, peer-reviewed publications, and presentations.

Details:

- Publication | Impacts of Coordinating the Colors of Flashing Warning Lights and Vehicle Markings on Driver Perception
- Presentation | Lights, Colors, Action! The Importance of Consistent Perceptual Information on Service Vehicles for Safe Driving
- Webinar | Safety First: Making Lighting Less Lethal
- Webinar | Proceed With Caution: Lighting for Emergency Vehicle Responder Safety

Silicosis Among Immigrant Engineered Stone (Quartz) Countertop Fabrication Workers in California (R13 Grant with additional support from a T42, U19, and U60)

Principal Investigator: Jane C. Fazio

Institution: University of California, Los Angeles (UCLA)

An emerging health concern among engineered stone countertop fabrication workers is a silicosis associated with inhaling respirable crystalline silica. In recent years, several clusters of silicosis among this worker population have been identified, calling attention to an accelerated and rapidly fatal form of silicosis. In response, UCLA investigators sought to describe the clinical, socioeconomic, and occupational characteristics of patients diagnosed with silicosis associated with engineered stone in California.

This case series used surveillance records from the California Department of Public Health. Patient interviews and medical records were used to measure occupational exposure and adverse risk factors associated with respirable crystalline silica. A total of 52 patients were identified in this process, most

of whom were young Latino male immigrants (98%). About half initially presented to an emergency department (48%). However, half were also either un- or under-insured (49%). Researchers saw a delay in diagnosis in 58% of patients; 38% already had advanced disease when diagnosed.

The median work tenure for these patients was 15 years (range: 10–20). Among the 52 cases, 23 (45%) reported using water suppression for dust migration, and 25 (48%) continued to fabricate stone after being diagnosed with silicosis. Ten (19%) of the cases were fatal, with a median age at death of 46 years (range: 38–51). Six patients (12%) survived with chronic resting hypoxia (low oxygen levels).

Dr. Fazio and colleagues published this case series in JAMA Internal Medicine in September 2023. Since then, this paper has been mentioned 362 times across news and media outlets and cited 23 times in other peer-reviewed publications. The study remains a highly regarded resource to inform silicosis exposure risk in occupational settings around the world.

Details: Publication | Silicosis Among Immigrant Engineered Stone (Quartz) Countertop Fabrication Workers in California

Influenza D Virus Exposure Among U.S. Cattle Workers: A Call for Surveillance (K01 Grant with additional support from a U54)

Principal Investigator: Jessica H Leibler

Institution: Boston University

Although cattle are a reservoir (or host) for influenza D virus (IDV), little is known about human exposure to IDV. Investigators from Boston University worked with other universities including the High Plains Center for Agricultural Health and Safety at Colorado State University. Together, they assessed IDV exposure and associated health effects among U.S. dairy workers.

Researchers studied 31 workers employed at five large-herd dairy operations in two states. They took samples during different shifts during the 5-day study period. They found evidence of IDV in the nasal washes of 67% of participants at least once. Further examination shows that IDV was not associated with respiratory symptoms. The "silent" nature of workers carrying the virus without symptoms reinforces the importance of actively monitoring spillover of this pathogen to humans.

Dr. Leibler and colleagues published this study as a short communication in the Zoonoses Public Health Journal in October 2022. Since then, the paper has been mentioned 69 times across news and media outlets and cited 22 times in other peer-reviewed publications.

Details: Publication | Influenza D Virus Exposure Among U.S. Cattle Workers: A Call for Surveillance

Face-to-Face With Scorching Wildfire: Potential Toxicant Exposure and the Health Risks of Smoke for Wildland Firefighters at the Wildland-urban Interface (K01 Grant)

Principal Investigator: Jooyeon Hwang

Institution: University of Oklahoma Health Sciences Center

With the continuing increase in wildfires comes an increase in the many health risks facing wildland firefighters. In June 2022, the International Agency for Research on Cancer reclassified the occupational exposure of structural and wildland firefighters as carcinogenic to humans, the highest hazard category. University of Oklahoma researchers partnered with Science, Technology, Engineering, and Mathematics (STEM)-focused scientists from several other U.S. universities to conduct a literature review. Their goal was to synthesize four main aspects of wildland firefighters' health risks at the wildland-urban interface, which is where wilderness meets urban development:

1. economic costs and health impact
2. respiratory protection
3. multipollutant mixtures
4. proactive management of wildfires

The investigators note that while wildfires cannot be avoided, protective action can be taken to improve the health of wildland firefighters. This includes

1. reducing the extent of toxicant exposures by conducting more prescribed burns
2. minimizing the frequency and risk of uncontrolled emergency wildfires
3. reducing the extent of exposure by designing more effective respiratory protection,
4. improving assessment methods on the effects of multipollutant exposures.

These actions will help firefighters and relevant professionals in the forestry workforce better measure and understand the overall health impacts.

Dr. Hwang and colleagues published this review as a viewpoint in The Lancet Regional Health – Americas Journal in March 2023. Since then, the paper has been mentioned 11 times across news and media outlets and cited 13 times in other peer-reviewed publications.

Details: Publication | Face-to-Face With Scorching Wildfire: Potential Toxicant Exposure and the Health Risks of Smoke for Wildland Firefighters at the Wildland-urban Interface

Impact of Patient Safety Climate on Infection Prevention Practices and Healthcare Worker and Patient Outcomes

Principal Investigator: Amanda J. Hessels

Institution: Columbia University

Standard precautions may prevent patients from getting infections while receiving healthcare and protect providers from occupational exposures. However, healthcare workers do not regularly use these precautions. A positive patient safety climate might help workers adhere to these safeguards. Investigators from Columbia University sought to determine the relationship among patient safety climate, standard precaution adherence, healthcare worker exposures, and the associated infections.

Researchers collected 5,285 standard precaution observations and 452 surveys across 43 hospital units. They observed about 64% adherence to all categories of standard precautions, which largely varied by provider role. Among major findings, key predictors of safety adherence and overall safety climate explained significant variation in adverse health outcomes associated with methicillin-resistant Staphylococcus aureus, catheter associated urinary tract infections, mucocutaneous exposures, and needlestick and sharps injuries.

This study produced findings that could advance occupational health and safety in the Healthcare and Social Assistance sector. Researchers found that patient safety climate was correlated with higher levels of self-reported and observed standard precaution behaviors. They also observed adherence to standard precautions is low across all professions and disciplines. Finally, they identified and documented specific standard precaution actions related to healthcare-associated infections and pathogen exposures.

These researchers used innovative methods, strategies, and approaches to collect and analyze multiple complex sources of data. By doing so, they identified several direct and indirect relationships among patient safety climate, adherence, healthcare workers, patient infections, and patient outcomes.

Dr. Hessels and colleagues published this study as original research in the American Journal of Infection Control in May 2023. Since then, the paper has been mentioned 18 times across news and media outlets and cited 7 times in other peer-reviewed publications.

Details: Publication | Impact of Patient Safety Climate on Infection Prevention Practices and Healthcare Worker and Patient Outcomes

COOPERATIVE RESEARCH AGREEMENTS

Cooperative agreements allow NIOSH to partner with universities, state health departments, labor unions, and nonprofit organizations to address important public health problems. NIOSH funds a broad array of these agreements to develop knowledge in preventing job-related injuries, illnesses, and fatalities.

In FY 2023, NIOSH funded the state OSH surveillance program to support states and other eligible jurisdictions in monitoring occupational illnesses, injuries, exposures, and fatalities in U.S. workers. Other cooperative agreements funded in FY 2023 included occupational safety and health surveillance collaboration, education, and translation; National Mesothelioma Virtual Bank; Commercial Fishing Occupational Safety Research and Training; and Mining Safety and Health Research. Selected highlights from the state OSH surveillance program and miner safety and health research are provided below.

State OSH Surveillance Program

Overview

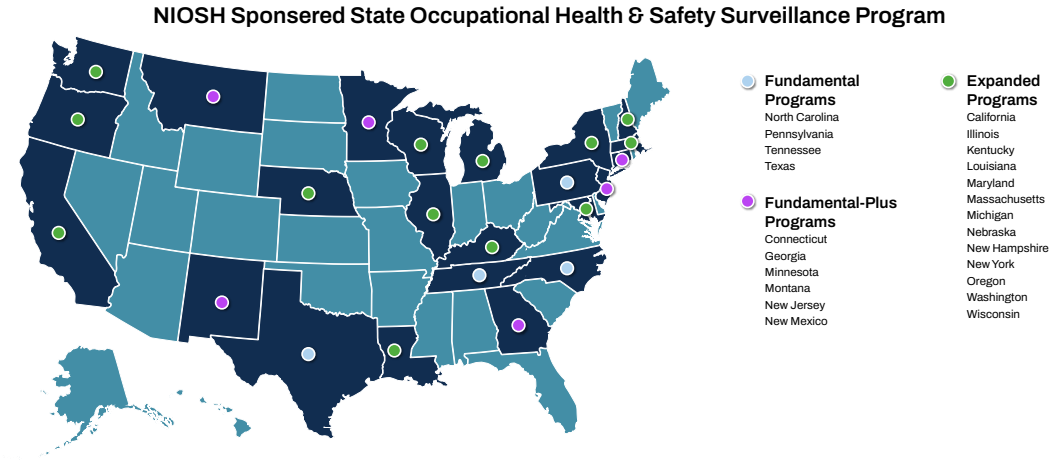
The state OSH surveillance program helps expand the ability of states and other eligible jurisdictions to monitor and respond to work-related health and safety issues. The program supports the role of states and others to conduct in-depth injury, illness, disability, and fatality surveillance, coupled with follow-up investigations and interventions when possible. Capacity for these activities among state public health partners helps NIOSH ensure safe and healthy workplaces, as authorized in the Occupational Safety and Health Act of 1970.

NIOSH funded 23 state OSH surveillance programs beginning in 2021. The programs have a portfolio of at least 30 unique projects that address numerous worker health and safety issues. For example, preventing injuries among youth workers or monitoring trends in work-related asthma. Many projects involve teamwork across multiple states to improve information sharing, speed the creation of evidence-based recommendations, and ensure recommendations are used in public health practice.

State programs are currently funded at three levels: (1) Fundamental, (2) Fundamental Plus, and (3) Expanded. All levels conduct Fundamental program activities, which include, but are not limited to, the following:

- Collect and report the nationally standardized Occupational Health Indicators (i.e., descriptive epidemiology).
- Establish or improve surveillance data access.
- Develop partnerships within state agencies.
- Communicate results to partners and the public.
- Engage with federal and other partners when needed.

Fundamental Plus programs add one or two enhanced or focused projects in surveillance, policy, or intervention. These projects are defined by the state prior to funding.



Expanded programs are funded at the highest levels for more advanced or resource-intensive activities and projects such as these:

- Expanded surveillance or prevention efforts for national priority, state-specific, or emerging issues.
- Case-based surveillance, follow-back, and case or worksite investigations.
- Advanced surveillance analysis (i.e., analytical epidemiology, data linkages) or developing new surveillance methods or tools (e.g., evaluation or prioritization frameworks, machine learning, data modernization initiatives).

Public Health Relevance

NIOSH provides financial and technical support to state health and labor agencies, universities, and other eligible groups to develop and expand their occupational health surveillance programs. Project topics include respiratory diseases, pesticide poisonings, worker fatalities, opioid use and overdose, heat-related illnesses, motor vehicle injuries, infectious diseases, and issues related to healthcare workers. These programs use and distribute surveillance data to find incidences of job-related injuries, illnesses, exposures, and fatalities. They help to discover trends, research and nonresearch opportunities, emerging issues, and high-risk worker populations. The programs also create and send out targeted educational and prevention materials, adapting materials to best protect workers. They often engage in outreach and involve partners in public health and safety to advance “data into action.”

Research Outputs: Publications in FY 2023

State OSH surveillance program outputs are the products of both nonresearch and research activities and include publications. From October 1, 2022, through September 30, 2023, the state OSH surveillance program published 20 articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by the state OSH surveillance program in FY 2023. The NIOSH State-based Occupational Health Surveillance Clearinghouse is a searchable database for many state surveillance reports, investigations, and other communication materials.

Program Highlights FY 2023

Measuring the Impact of COVID-19 on Workers: Wisconsin Success Story

Institution: Wisconsin Department of Health Services

Work-related exposures played an important role in severe acute respiratory syndrome coronavirus (SARS-CoV-2) transmission. When COVID-19 started affecting workplaces in 2020, the need for standardized industry and occupation data collection became clear.

Starting in September 2020, Wisconsin's Occupational Health and Safety Surveillance Program implemented industry and occupational fields into the COVID-19 case interview form. This was done so that free-text responses could be auto-coded using the National Industry and Occupation Computerized Coding System. Additional efforts were made to collect employment information to link COVID-19 case data to the Wisconsin Electronic Disease Surveillance System. Investigators aimed to better identify worker populations and fill data gaps to find the most impacted workers across variable demographic and employment characteristics.

These multipronged efforts paid off. The Wisconsin Department of Health Services used these data to calculate COVID-19 incidence rates for different industries and occupations. This allowed them to target messaging for at-risk workers. This effort served as a model for other states that want to scale up their occupational surveillance programs.

- An estimated 11.6% (347,013 of 2.98 million) of Wisconsin workers ages 18–64 had COVID-19 from September 2020 to May 2021.
- Highest incidence by occupation: personal care and service workers (22.1 per 100 FTE), healthcare practitioners and support staff (20.7 per 100 FTE), protective service workers (20.7 per 100 FTE).
- High-risk subgroups included nursing assistants and personal care aides (28.8 per 100 FTE); childcare workers (25.8 per 100 FTE); food and beverage service workers (25.3 per 100 FTE); personal appearance workers such as barbers, hairstylists, manicurists, etc., (24.4 per 100 FTE); and law enforcement workers (24.1 per 100 FTE).

This analysis represents one of the most complete examinations to date of COVID-19 incidence by occupation and industry. The investigators' approach demonstrates the value of standardized occupational data collection by public health. It may also be a model for improved occupational surveillance even beyond the COVID-19 pandemic.

Details:

- Blurb | The Challenge: Measuring the Impact of COVID-19 on Workers
- Publication | Measuring Work-related Risks of Coronavirus Disease 2019 (COVID-19): Comparison of COVID-19 Incidence by Occupation and Industry–Wisconsin, September 2020 to May 2021
- Publication | School District Prevention Policies and Risk of COVID-19 Among In-Person K-12 Educators, Wisconsin, 2021
- Publication | Lost Time: COVID-19 Indemnity Claim Reporting and Results in the Wisconsin Workers' Compensation System From March 12 to December 31, 2020

Excess Risk Of SARS-CoV-2 Infection Among In-Person Nonhealthcare Workers in Six States, September 2020–June 2021

Institutions: Georgia Department of Public Health, New Hampshire Department of Health and Human Services, North Carolina Department of Health and Human Services, Pennsylvania Department of Health, California Department of Public Health, and Wisconsin Department of Health Services

Throughout the pandemic, the occupational risk of SARS-CoV-2 was well characterized for healthcare personnel. However, this was not always the case among workers in other settings. To address this knowledge gap, six state-based occupational health surveillance programs from California, Georgia,

Pennsylvania, Wisconsin, New Hampshire, and North Carolina collaborated with NIOSH to evaluate the excess risk of SARS-CoV-2 infection by occupation and industry among nonhealthcare workers.

Investigators first analyzed data from a six-state callback survey of adult nonhealthcare workers with confirmed SARS-CoV-2 infection. Next, they used a population-based reference to estimate how the distribution of SARS-CoV-2 infections varied, while adjusting for the impact of telework.

In a sample of 1,111 workers with confirmed SARS-CoV-2 infections, researchers found significantly higher-than-expected proportions of workers employed in service occupations (30% higher), transportation and utilities (40% higher), and leisure and hospitality industries (50% higher).

These results show clear differences in proportionate distribution of SARS-CoV-2 infection by occupational and industry. The findings underscore the heightened burden of SARS-CoV-2 infection borne by some worker populations, particularly those whose jobs require frequent or prolonged close contact with others. The groups with elevated infections are also disproportionately made up of women workers, racial and ethnic minority workers, and low-income workers. The findings emphasize the contribution of work-related SARS-CoV-2 transmission to observed differences in health outcomes across worker populations.

Details: Publication | Excess Risk of SARS-CoV-2 Infection Among In-Person Nonhealthcare Workers in Six States, September 2020–June 2021

Addressing Workplace Violence in New Hampshire Hospitals

Institution: New Hampshire Department of Safety & the University of New Hampshire

Violence in healthcare settings greatly impacts workers, leading to posttraumatic stress, anxiety, and depression. It can also affect the overall functioning of healthcare systems by increasing burnout and creating obstacles to employee retention. In addition, workplace violence can affect the quality and safety of patient care.

In 2020, a group of healthcare professionals and public health advocates in New Hampshire formed The New Hampshire Healthcare Violence Prevention Group. They began a pilot study aimed to find how often violence occurred among healthcare workers in different facilities.

In collaboration with the New Hampshire Occupational Health Surveillance Program, the group conducted an online survey-based study of staff experiences of violence in emergency departments (EDs). Staff from six New Hampshire hospitals participated in the survey, which received over 200 total responses.

Their findings showed that three of four ED staff experienced some form of violence in the last 6 months. This included verbal aggression, physical aggression, sexual aggression, harassment, or intimidation. Among these ED workers, two of three experienced multiple forms of violence and one of three thought about leaving their jobs or professions because of the incident(s). Less than half of these workers officially reported the incident(s), largely due to lack of confidence in any change.

As a result of this work, all six participating hospitals agreed to coordinate action steps for improvement and create a new dialogue around workplace violence in healthcare settings to achieve best practice for improving staff and patient safety. This process can produce improvements in an area that can have far-reaching implications for occupational safety and health in the Healthcare and Social Assistance sector.

From the CSTE Occupational Health Success Story:

"While this report isn't breaking news to bedside staff, it is incredibly eye opening to hospital leadership and non-bedside providers. My hope is that the data in this report can bring to light how violent healthcare has become, and that the hospital relationships that grow out of this group will allow the sharing of best practices to help keep all New Hampshire healthcare workers safe." - Stacey Carroll, MSN, RN, CCRN-K, NHDP-BC Director, EMS Coordinator Southern New Hampshire Health

Details:

- Council of State and Territorial Epidemiologists | Occupational Health Success Story, Addressing Workplace Violence in NH Hospitals
- NIOSH eNews News From Our Partners Post | Violence & Aggression in Health Care
- Full Report | Violence & Aggression in Health Care

Heat-related Illness in Louisiana

Institution: Louisiana Department of Health

Heat exposure is of concern in Louisiana, a state that experiences some of the highest average summer temperatures in the United States. Louisiana's hot summers are compounded by high humidity. This worsens the impact of heat by impairing the body's ability to cool by evaporation. Every year in Louisiana, thousands of people are treated in emergency departments or hospitalized due to heat.

In response, the Louisiana Department of Health examined heat-related illness for Louisiana residents and workers from 2010 through 2020 to better understand variations in heat-related ED and hospital visits and inform public education programs, policy, and prevention efforts.

On average, there were 323 work-related ED visits and 20 work-related hospitalizations for heat-related illness every year in Louisiana. Male workers accounted for 90% of ED visits and 96% of hospitalizations. Workers ages 34 years and younger had the highest rates of ED visits. Black workers had 1.5 times more ED and 2 times more hospitalization rates compared with White workers. These results were part of a larger program strategy to improve the consistency, reliability, and timeliness of health data related to heat exposure. The goal is to also use these data to inform climate resilient policies and practices.

Details:

- Full Report | Heat-related Illness in Louisiana: Review of Emergency Department and Hospitalization Data From 2010–2020
- Fact Sheet | Heat & Health: What You Need to Know
- Website | Louisiana Occupational Health-related Illness Prevention Program

Miner Safety and Health Research

Overview

In 2023, NIOSH supported three cooperative agreements to address pressing needs in the Mining sector: two cooperative agreements for the Underground Mine Evacuation Technologies and Human Factors and one cooperative agreement for the Robotic and Intelligent Mining Technology and Workplace Safety Research.

Public Health Relevance

Despite advances in technology and the work environment, mining remains one of the most challenging and dangerous occupations in the United States. In 2023, there were 324,300 workers in the Mining sector according to data reported in Mine Safety and Worker Charts. That same year, MSHA reported 12,616 mining operations in the United States. In 2023, 3,664 nonfatal lost-time mining injuries occurred. This was an average of 1.43 per 100 full-time equivalent workers.

Research Outputs: Publications in FY 2023

Miner Safety and Health Research outputs are the products of both nonresearch and research activities and include publications. Authors collected publications by reviewing NIOSH Extramural Award Tracking, the NIH RePORTER database, the NIOSHTIC-2 database, and the PubMed database. From October 1, 2022, through September 30, 2023, Miner Safety and Health Research published three articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that

preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by Miner Safety and Health Research in FY 2023.

Program Highlights FY 2023

Advancing Robotic Safety for Mine Rescue

Project Title: Design and Demonstration of Intelligent Mine Evacuation and Mine Rescue System

Institution: New Mexico Institute of Mining and Technology

During a mine emergency, the hazardous environment presents significant risks and challenges to rescue efforts. The use of smart systems that use robots to help in mine rescues has become more common. However, following an incident, the communication infrastructure within mines is often compromised or insufficient to handle the network traffic needed by these systems. A temporary, deployable communication network capable of supporting both time-sensitive environmental monitoring (e.g., toxic or flammable gases) and high-throughput data transmission, such as video or 3D mapping, would improve communications during mine emergencies and assist in rescues.

To address this challenge, investigators at New Mexico Tech developed a wireless mesh network featuring droppable nodes (portable units). These wireless mesh networks and battery-free communication systems enhanced situational awareness and coordination during rescue missions.

Investigators also examined other issues, such as underground mine fires, which cause smoke, toxic gases, low visibility, and changes in the ventilation system. They presented a method for solving the maximum cost flow network problem for safely evacuating workers while considering the way toxic gases spread inside the mine in real-time. The method involved the design and use of a multi-agent robotic system that included unmanned drones (Unmanned Aerial Vehicles) and robots (Unmanned Ground Vehicles). These robotic vehicles were equipped with technology that helped them navigate in areas without GPS.

These collective efforts have significantly improved the safety and efficiency of mine rescue operations.

Details:

- Publication | Droppable Wireless Mesh Network for Intelligent Mine Rescue System
- Publication | Optimization for Fire Evacuation Applying Maximum Flow Cost Algorithm to Improve the Time-response in Underground Coal Mines

Robotic Safety Enhancements

Project Title: Research, Technological Innovations and Human Factors for Effective Miner Self-Escape from Underground Mine Emergencies

Institution: Missouri University of Science and Technology

Including a commercially available robotic dog in mining emergency procedures showcases how robotics can revolutionize underground mining safety. Investigators at Missouri University enabled the robot to find people in a mine after a disaster. The robots used infrared imaging, improved navigation, and sensory skills to scout hazardous zones. Researchers used focus groups to demonstrate key robotic functions, which included gas monitoring, object detection, and equipment transport, for improved safety in emergency scenarios.

This project successfully tested infrared imaging for detecting people in obstructed environments. The project received positive miner feedback on robotic roles in improving evacuation efficiency and safety.

Details:

Publication | MinerFinder: A GAE-LSTM Method for Predicting Location of Miners in Underground Mines

SPECIALTY TRAINING PROGRAMS

NIOSH funds TPGs, Commercial Fishing Occupational Safety Training Grants, and the Miner Safety and Health Training Program—Western United States Cooperative Agreement. Selected highlights from TPGs and the Miner Safety and Health Training Program—Western United States are provided below.

Training Project Grants

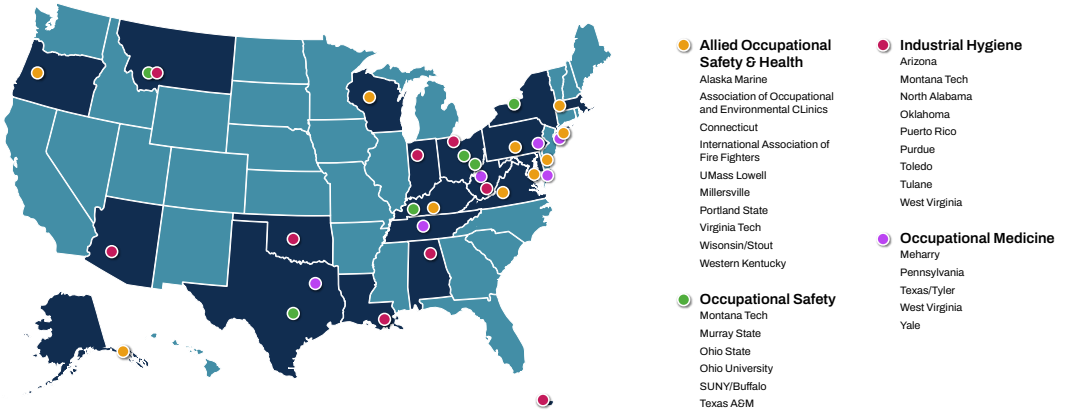
Overview

NIOSH supports training in occupational safety and health through TPGs. Most TPGs are academic training programs that support undergraduate, graduate, and post-graduate training. Located throughout the United States, these programs enrich the national network of graduate training the ERCs offer. Along with TPGs for traditional degree training programs, NIOSH supports TPGs that respond to the unique training needs of specialty groups. For example, the Alaska Marine Safety Education Association expands the network of port-based fishing safety instructors in Alaska and the United States. They achieve this through a train-the-trainer curriculum designed for the unique needs of the commercial fishing industry. NIOSH also provides funding for the Emergency Responder Training Program through the IAFF.

Public Health Relevance

TPGs offer an important service by providing an adequate supply of qualified professionals to carry out the Occupational Health and Safety Act of 1970. TPGs train in specific disciplines to meet workforce needs. The graduates of TPGs serve a vital role in protecting and promoting the health and safety of U.S. workers. TPGs also serve as important resources on job-related safety and health issues for business, labor, government, and the public.

NIOSH Training Project Grants



Research Outputs: Publications in FY 2023

TPG research outputs are the products of research activities and include publications. From October 1, 2022, through September 30, 2023, TPG researchers published 19 articles in peer-reviewed journals. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by TPGs in FY 2023.

Program Highlights FY 2023

Training Project Grant Trainees, Graduates, and Employment by Discipline

In academic year 2022–2023, the TPG academic training programs enrolled 652 trainees. Of these, 185 graduated with specialized training in industrial hygiene, occupational safety and medicine, and allied disciplines. These allied disciplines included occupational health psychology, risk management, occupational ergonomics and engineering, environmental health, and occupational epidemiology.

One recent TPG graduate provided a testimonial of their experience:

> **"I am confident that I can be an effective organizational contributor in this operator-oriented position, thanks to the similar function of my practicum. Last summer, I worked as the Safety Intern at [utilities services company]. Through my assigned duties, I learned many important lessons, the most valuable of which being the significance of communication in safety's iterative processes. Beyond my [utilities services company] experience, I have also developed as an emerging professional through my occupational safety and health coursework."**

Table 9. Training project grant trainees, graduates, and employment by discipline, FY 2023

Program Area	Trainees	Graduates	Employed in occupational safety and health field or seeking advanced training (%)
Industrial Hygiene	247	55	53 (96)
Occupational Safety	183	68	61 (90)
Occupational Medicine	39	18	12 (67)
Allied Disciplines	183	44	39 (89)
Total	**652**	**185**	**165 (89)**

Note: Allied Disciplines include the following interdisciplinary areas: Occupational Epidemiology, Occupational Injury Prevention Research, Transportation Safety (TRT Research), Occupational Biomechanics, Total Worker Health, Occupational Health Psychology, Agricultural Safety & Health, Human Factors & Ergonomics, Biomonitoring, Occupational Health Services Research, Occupational Health at the Human-Animal Interface, Work and Health Graduate Certificate, Ergonomics, Climate and Worker Health and Safety, Health Physics, Mining Health and Safety, Occupational Athletic Training, and Health, Safety, and Environment.

Training Project Grant (TPG) Program Achievements

The Application of Portable Air Cleaners in Spaces Occupied by Vulnerable People During Wildfire Events

Institution: Department of Safety, Health, and Industrial Hygiene, Montana Technological University

As the Western United States has experienced an upward trend in the duration and severity of wildfire seasons, this work has played a critical role in public health protection. Layne Willis, a NIOSH TPG and student at Montana Technological University, collaborated with local health officials and an EPA-sponsored Wildfire Readiness Team to assess the impact of portable air purifiers in locations where

vulnerable populations spend considerable time in the indoor environment. These populations included classrooms in a Head Start preschool, living quarters in a homeless shelter, and assisted living facilities.

The results of this study show that using a portable air cleaner greatly reduces the amount of time an occupant is exposed to unhealthy concentrations of wildfire-induced PM2.5. Portable air cleaners perform most efficiently at or below their designed room square footage. However, even if a portable air clearer is not available, staying indoors is still an effective option to decrease wildfire PM2.5 exposure.

The team published this work in the World Safety Journal in June 2023. Since then, this paper has been cited one time in another peer-reviewed publication.

Details:

- Publication | The Application of Portable Air Cleaners in Spaces Occupied by Vulnerable People During Wildfire Events
- Journal | World Safety Journal 2023
- Presentation | Analysis of Toxic Fumes Emitted During Small Scale Lithium-Ion Battery Fires

A Markov Chain Model for Mental Health Interventions

Institution: Department of Mechanical and Industrial Engineering, University of Massachusetts Lowell

Poor mental health affects nearly one billion people worldwide. It can end in suicide if left untreated. Unfortunately, stigma and a lack of mental healthcare providers are barriers to receiving needed care. Researchers from the University of Massachusetts Lowell developed a Markov chain model to determine whether decreasing stigma or increasing available resources improves mental health outcomes.

The mental healthcare continuum was mapped based on two entirely opposite outcomes: getting better or completing suicide. Results showed the following:

A 12% increase in awareness of mental health concerns yields a 0.39% reduction in suicide.

A 12% increase in access to professional help yields a 0.47% reduction in suicide.

Expanding access to professional services has an overall higher impact on reducing suicide rates compared with creating awareness. However, both provide a protective effect. Awareness campaigns help increase public recognition of mental health needs. They can also serve as the first step for those that need access to mental health resources.

Dr. David Claudio and colleagues published this work in the International Journal of Environmental Research and Public Health in February 2023. Since then, this paper has been cited seven times in other peer-reviewed publications.

Details: Publication | A Markov Chain Model for Mental Health Interventions

Improving Crew Overboard Recovery for Commercial Fishing

Institution: School of Medicine, The University of Texas at Tyler Health Science Center

Occupational fatality rates in the U.S. commercial fishing industry remain more than 20 times higher than the national average. These fatalities are often due to unintentional falls overboard. The shrimp fishery, operating in the waters between Florida and Mexico, experiences the highest fatality rates. Researchers from The University of Texas at Tyler Health Science Center conducted a pre-post study to assess the attitudes, beliefs, and intentions of adopting recovery slings to shrimp fishery captains and deckhands.

Figure 13. Commercial fishermen study participants practice one and two-person hoisting of a manikin using a tripod with mechanical advantage, a recovery sling, and a low ledge barrier used to simulate the railing of a vessel deck (Galveston, Texas).

Photo by Levin et al. 2023/Creative Commons License

Due to the COVID-19 pandemic during the study period, a land-based simulation was used to train commercial fisherman at three port locations as shown in Figure 13. Fishermen received one recovery sling per vessel along with a task list of instructions.

After 12–18 months, researchers observed positive changes in the fishermen's deeply held beliefs. This means that attitudes could be influenced toward using a crew overboard recovery device. Researchers also saw fishermen's confidence and intention to use such devices increase. However, results also showed attitudes and beliefs may wane over time. This emphasizes the importance of repeated training and survival drills in this industry.

Dr. Jeffrey Levin and colleagues, including several TPG faculty and students, e-published this work in the Journal of Agromedicine in June 2023. Since then, this paper has been cited two times in other peer-reviewed publications.

Details: Publication | Improving Crew Overboard Recovery for Commercial Fishing in the Gulf of Mexico

Emergency Responder Training Program

Overview

Through the IAFF, NIOSH supports a nationwide program to enhance the capabilities of firefighters engaged in emergency response through training. The training is site- and trade-specific and aims to reduce on-the-job injuries, illnesses, and fatalities related to emergency response. Therefore, responders are better able to protect the communities they serve.

The IAFF has a long working relationship with NIOSH. Their Emergency Responder Training Program is part of a complete first responder training plan. IAFF's teachings seek to improve knowledge, attitudes, and behaviors so that first responders adopt a safer approach to emergency response throughout their career. Their training is a resource that directly affects decisions firefighters make every day.

Public Health Relevance

This training program serves as an excellent model for an effective first responders training program. With a team of instructors who are both certified fire service instructors and hazardous materials (HazMat) responders, IAFF provides real-world training in HazMat response. Furthermore, IAFF brings its training directly to the students in their own communities, developing training partnerships with thousands of fire departments throughout the United States. Because of this community-based learning, local responders receive training that addresses their unique concerns and challenges.

As the opioid overdose epidemic continues, all levels of emergency medical service providers must be properly trained to handle these life-threatening events, including the administration of naloxone (NARCAN®). In response, IAFF developed an Opioid Crisis Toolkit, which uses the protocols, state-of-the-art responses, and resources available to firefighters.

Program Highlights FY 2023

In FY 2023, IAFF delivered 114 classes to 2,401 students, totaling 41,528 contact hours. Table 10 provides a full description of emergency responder training classes by program.

Table 10. Emergency responder training classes, FY 2023

Program	Classes	Students	Contact Hours
Responding to Drug Lab Incidents (DRI)	16	339	2,712
DRI Train-the-Trainer	2	17	136
Emergency Response to Terrorism Operations	30	592	4,736
Emergency Response to Terrorism: Train-the-Trainer	2	50	400
Hazmat Operations (HMO)	60	1,347	32,328
High Consequence Incidents	1	8	64
Confined Space Operations	3	48	1,152
Total	**114**	**2,401**	**41,528**

Miner Safety and Health Training Program

Overview

The Mine Safety and Health Administration (MSHA) Training Academy in Beckley, West Virginia, serves the mining community in the Eastern United States. This training program is not easy for miners in the Western States to access. In addition, certain aspects of mining operations differ in eastern and western operations. Therefore, NIOSH has supported miner safety and health training in the Western United States since 1999.

For FY 2023, two programs were funded in the Western United States: the Colorado School of Mines and the University of Arizona. This training provides a joint approach to reducing occupational illnesses, injuries, and fatalities to miners and other workers in mining operations. It also aims to translate research into workplace practices that

- Improve mining safety
- Advance the safety and health of miners
- Enhance the safety and health of other workers involved in mining operations
- Increase the quantity of qualified mine safety and health trainers in the Western United States

There are several objectives of the training program:

- Develop, deliver, and manage the training needs of miners in the Western United States.
- Provide qualified instructors and faculty.
- Start and carry out "train-the-trainer" courses.
- Evaluate training effectiveness and impact on reducing injuries and illnesses to miners.
- Coordinate with existing training programs, like those offered by MSHA and MSHA-funded state programs, and in partnerships with industry, miners, and other agencies.

NIOSH intends for the program's training to be consistent with OSHA and MSHA guidelines, without duplicating these agencies' existing trainings.

Public Health Relevance

Recent research shows that 24 mining workers died in 2019—the lowest number of fatalities in MSHA's history. NIOSH Mine and Worker Charts show trends over time. In 2020, there were 29 mining deaths, making it the sixth consecutive year in the agency's history that mining industry fatality numbers were below 30. This was followed by 37 deaths in 2021, 29 deaths in 2022, and 40 in 2023. While this improvement cannot be solely attributed to effective safety training, such interventions likely contribute to these outcomes. A recent evaluation of the NIOSH Mining Program noted that MSHA takes advantage of knowledge and products provided by the NIOSH-funded Miner Safety and Health Training Program—Western United States.

The Miner Safety and Health Training Program provides critical safety and health training to protect workers in one of the most dangerous industry sectors in the United States. This program contributes to this overall goal by taking the following actions:

- Expanding the mission of NIOSH in protecting and promoting the health of mine workers. The trainings improved work practices, reduced work-related injury and illness, and increased the understanding of safety and health practices in western mine worksites.
- Increasing the safety focus, total health awareness, and leadership competency of miners, frontline supervisors, superintendents, and managers representing operations throughout the United States, spanning all major commodity sectors in surface and underground mining.
- Directing the focus of mine-rescue training toward learning actual rescue skills, resulting in team members being better prepared to respond to all kinds of emergencies.

The Miner Safety and Health Training Program fills an important regional need. During FY 2023, the two cooperative agreements trained 7,109 mining industry personnel through the Training Resource Centers and Learning Laboratory programs. 6,847 mining industry personnel received training out of the University of Arizona, and 262 mining industry personnel received training out of the Colorado School of Mines. A total of 447 individual courses and workshops were administered across the two universities to include professional development, supervisory training, and exercise programs. Trainees included miners, supervisors, and undergraduate and graduate engineering and geology students.

The program is critical for populations working on mine sites, including contractors, suppliers, consultants, equipment manufacturers, and small mine operators. The program designs and uses active learning strategies for mine safety training. Trainers across all mining service sectors throughout the Western United States have been taught ways to improve safety training. These activities improve the transfer of best safety practices to the workplace while increasing the number of workers served.

Program Highlights FY 2023

Mining Strong Card Game

Project Title: Western Mining Safety and Health Training Resource Center: Facilitating Research to Practice through Learning

Institution: University of Arizona

Investigators at the Western Mining Safety and Health Training Resource Center collaborated with the Colorado School of Mines to develop the Mining Strong Card Game, an innovative health training tool for miners. The game aims to address gaps in knowledge of TWH and industrial hygiene and empowers workers to adopt healthier habits in their workplaces. The game requires players to work together to control for health hazards and improve overall health.

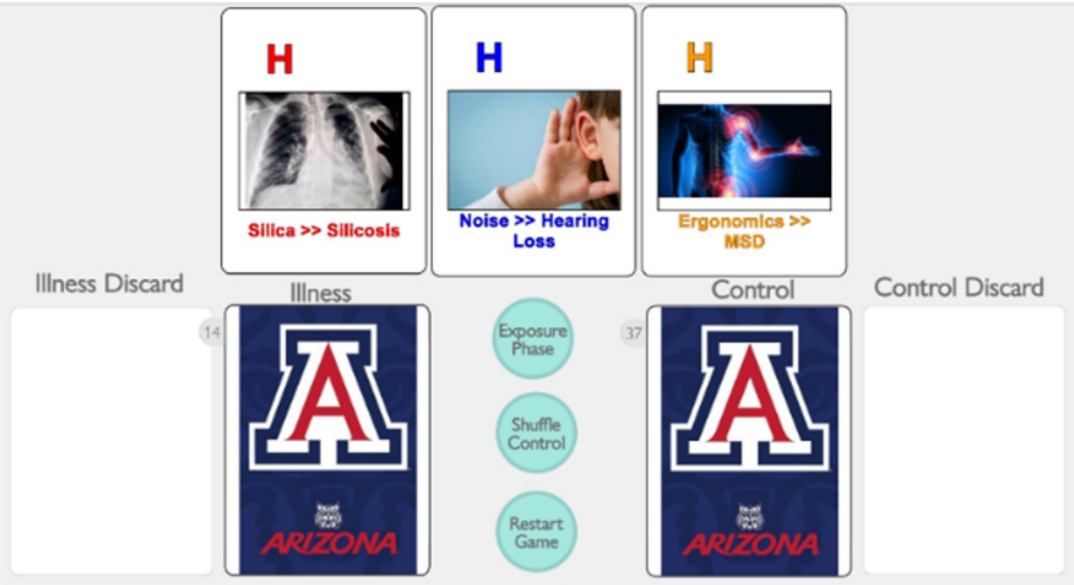


Figure 14. Mining Strong card game.

Image by Reed et al. 2021

The game includes modules on mental fatigue, nutrition, exercise, substance use, heat stress, and fitness (aligning with Total Worker Health). Its design can be adapted for various health and safety hazards, making it suitable for diverse working environments. An example of game cards is shown in Figure 14.

The Mining Strong Card Game has been play-tested by over two dozen mining safety and health trainers.

Investigators have distributed more than 150 physical copies of the training cards to mine operators and trainers through conferences, mail, and training sessions Tabletop and web-based versions are currently being developed.

Details: Online Version | Mining Strong Card Game

Commercial Fishing Research and Training

Overview

The Commercial Fishing Occupational Safety Research and Training Program is a partnership between the U.S. Coast Guard and NIOSH. It was created to support research and training projects that improve the safety and health of commercial fishermen. The program is responsive to the Coast Guard Authorization Act of 2010 (P.L. 111-281) as amended by the Howard Coble Coast Guard and Maritime Transportation Act of 2014 (P.L.113-281). Some of its research and training projects include vessel design, emergency and survival equipment, vessel monitoring system improvements, communications devices, deicing technology, and severe weather detection.

The training project grant program aims to enhance the quality and availability of safety training for commercial fisherman. The specific program objectives are as follows:

- Address the training needs of commercial fisherman with regional differences and specific fleets in mind.
- Increase the number of qualified maritime safety and drill instructors to deliver different types of trainings, including emergency drills, survival, damage control, fire prevention and firefighting, stability, seamanship, fatigue awareness and prevention, watchkeeping, and weather forecasting.
- Develop, offer, and implement "train-the-trainer" and refresher courses.
- Develop and deliver hands-on safety training to commercial fisherman.
- Provide qualified instructors and faculty to achieve the program goals.

Public Health Relevance

Commercial fishing is one of the most dangerous occupations in the United States. The hazards fishermen face can vary widely by vessel and fishery. Despite recent successes in reducing fatal work-related injuries, targeted research and training for commercial fishing remains important.

Research Outputs: Publications in FY 2023

From October 1, 2022, through September 30, 2023, Commercial Fishing Research and Training published five articles in peer-reviewed journals. Note that publications in FY 2023 may have been funded by NIOSH awards that preceded the fiscal year. Find a searchable database of NIOSH publications, which includes grantee final reports and publications, by using the NIOSHTIC-2 publications search. Note several other research outputs, aside from publications, were produced by Commercial Fishing Research and training in FY 2023.

Program Highlights FY 2023

Fighting the Opioid Epidemic by Training Fishermen as First Responders

Principal Investigator: John Bartlett

Institution: Fishing Partnership Health Plan

Death certificate data in Massachusetts shows that opioid-related overdose deaths varied significantly by industry, and that workers in the Farming, Fishing, and Forestry sector were among those industries with the highest rates. Until recently, opioid education and naloxone distribution training has been limited in the commercial fishing industry. Even when the training was available, attempted behavior changes in the fishing industry were met with social and cultural barriers. These collective issues result in overall poorer health outcomes for fishing communities.

In response, the Fishing Partnership Support Services (FPSS) used a community-based model to overcome barriers and empower commercial fishermen as first responders to combat the opioid epidemic. They designed the opioid education training to be administered by trusted representatives in the fishing community as part of a larger health and safety program. During the first year of the project, FPSS qualified five community health workers as instructors who trained and equipped over 700 members of the fishing community as first responders. In addition, over 90% of trainees reported they are now carrying naloxone or intend to start carrying naloxone because of the training program.

Since these trainings, 17 fishermen who received naloxone from FPSS reported using it at the scene of an overdose.

Details:

- Report | Opioid-related Overdose Deaths Among Injured Workers in Massachusetts: Findings From the Public Health Data Warehouse
- Publication | Naloxone Training and Availability in the U.S. Commercial Fishing Industry

The Intersection of Sleep and Health in Commercial Fishing

Work for commercial fishers is very risky when considering its long and irregular work shifts, intense work, erratic and extreme weather, and dangerous equipment. All these factors can impact fishermen's sleep patterns, often limiting them to only a few hours of sleep per day with inconsistent sleep and wake schedules when sleep is even possible. These impacts on sleep pose concerns to overall health and on-the-job injuries and fatalities among commercial fishermen.

The Northeast Center for Occupational Health and Safety and its partners collaborated with fishermen from Alaska, Oregon, and the US Northeast to better understand the intersection of sleep and health in commercial fishing. The study found the following:

Fishermen generally get less than 5 hours of sleep per day while out at sea.

Pain significantly impedes their quality and duration of sleep.

Positive screening rates for posttraumatic stress disorder symptoms were three times higher in men who participated in the survey compared with the national average.

Details: Website Portfolio | Northeast Center for Occupational Health and Safety: Sleep Deprivation at Sea

IV. WORLD TRADE CENTER (WTC) HEALTH PROGRAM

The terrorist attacks of September 11, 2001, have caused an array of acute and chronic adverse health conditions in the exposed populations. According to research, over 400,000 people are believed to be at an increased risk of adverse health effects from their exposure to physical, psychological, and emotional stressors from the event. Many people with 9/11-related illnesses often have other health problems, further lowering their quality of life. These health problems may have been acutely onset immediately following the attacks or developed in the years after their exposures, both of which necessitate long-term follow-up care.

Shortly after the attacks, CDC and NIOSH provided funding to support a variety of post-disaster activities including medically evaluating and monitoring responders, establishing the WTC Health Registry, and publishing treatment guidelines for adults and children exposed to the disaster. As a result of the combined efforts of researchers, physicians, responders, survivors, local governments, research institutions, and the community, Congress created the WTC Health Program with the passage of the James Zadroga 9/11 Health and Compensation Act of 2010 (Zadroga Act).

The WTC Health Program provides medical monitoring and treatment for specific symptoms and health conditions for people who worked in response, recovery, and cleanup operations at the WTC, the Pentagon, and the passenger-jet crash site near Shanksville, Pennsylvania. The WTC Health Program also offers initial health evaluations, monitoring, and treatment for survivors of the attacks in New York City. Furthermore, the Zadroga Act (Public Law 111-347, as amended by Public Laws 114-113, 116-59, 117-328, and 118-31) requires ongoing research activities, maintenance of the WTC Health Registry, and outreach and educational activities to potential enrollees. OECSP manages the extramural portfolio of cooperative agreements for the WTC Health Program. This portfolio includes the WTC Health Registry and individual cooperative research agreements and grants, as discussed in this section. For more information about the WTC Health Program research portfolio, see the WTC Health Program Research Funding Dashboard.

WTC HEALTH PROGRAM RESEARCH PORTFOLIO OVERVIEW

Research Solicitation and Funding

The WTC Health Program Research-to-Care Model conducts and assesses research in order to inform clinical care for the population of responders and survivors affected by the 9/11 attacks. To review the current WTC Health Program research agenda and the Research-to-Care Model, please visit the WTC Health Program Research Agenda.

Each year since late 2011, the WTC Health Program has solicited applications for scientifically rigorous research to help answer critical questions about physical and mental health conditions related to the September 11, 2001, terrorist attacks. From 2011 through 2023, the WTC Health Program reviewed a total of 410 research proposals, which included contracts but excluded the initial and renewal awards of the WTC Health Registry. Note there are other projects that WTCHP funds that are in partnership with other agencies and not described in this report. Out of the contracts, the WTC Health Program selected 122 (30%) projects, in addition to the WTC Health Registry, for funding. Prior to moving to NIOSH in 2009, the Registry was administered by the Agency for Toxic Substances and Disease Registry and the National Center for Environmental Health. The Registry sits within the New York City Department of Health and Mental Hygiene.

During FY 2011–2023, the WTC Health Program funded 122 research projects (excluding the WTC Health Registry) for a total of $161.2 million. During FY 2011–2023, the WTC Health Program continued to fund the WTC Health Registry project for a total of $91.3 million. Total research funding during FYs 2011–2023 for the 122 research projects and the WTC Health Registry is shown in Figure 15. Additionally, see Table 11 for the distribution of awards and funding across WTCHP-specific awards categories and mechanisms for FY 2023. For a listing of all funded projects awarded and the current status of funded projects, see the WTC Health Program Research Funding Dashboard.

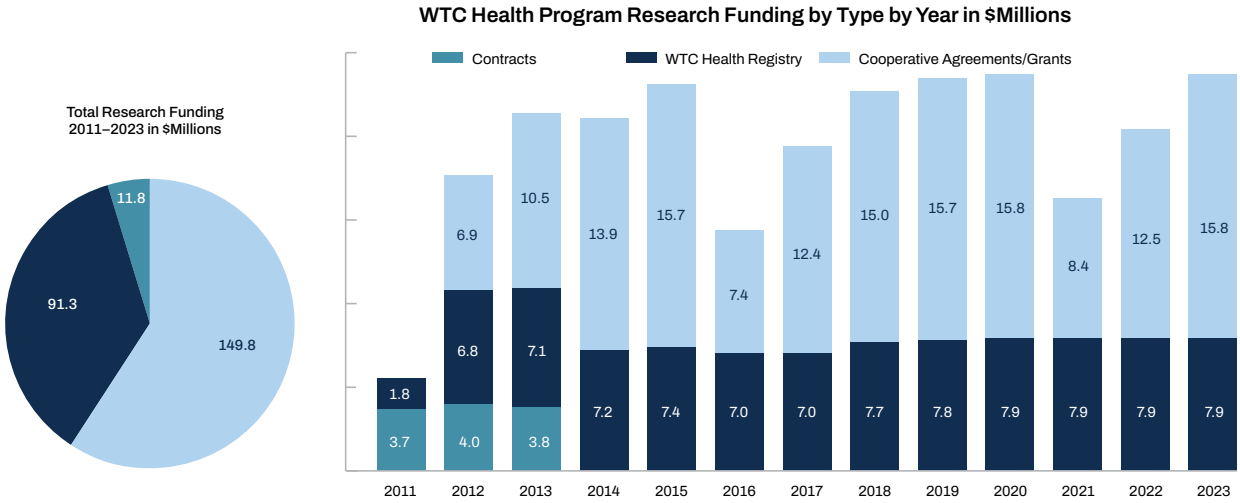


Figure 15. Research funding (in $ Millions) for FY 2011–2023 research cooperative agreements, WTC Health Registry, and research contracts.

Note data in this figure are rounded to the nearest tenth.

Table 11. World Trade Center Health Program funding, FY 2023

Award Category	Award Mechanism	Number of Awards	Funding
World Trade Center Health Program, All		13	$12,916,893
Exploratory/Developmental Grants Related to the WTC Health Program	Investigator-initiated (R21)	4	$1,031,200
World Trade Center Research	Cooperative Agreements (U01)	8	$3,990,693
World Trade Center Health Registry	Health Registry	1	$7,895,000

*The data in Table 11 do not include active projects funded with prior year funding through no cost extensions.

Of the 122 projects awarded since 2011, 39 (32%) are active and 83 (68%) are completed (closed). Seven of the active projects and 62 of the closed projects produced 229 publications. The WTC Health Program organizes its research projects and outputs or products, including publications, into six primary focus areas:

1. Respiratory disease
2. Adult mental health
3. Cancer
4. Emerging conditions
5. WTC youth
6. Cardiovascular disease

External program partners and NIOSH leadership contributed to the development of these focus areas. The categories were based on 9/11-related illnesses identified by clinicians treating the impacted populations. They also stem from reviewing research publications on WTC-related health conditions and assessing the physical and mental health conditions covered by the WTC Health Program. These latter conditions have been determined to be aggravated by, contributed to, or caused by exposure to the 9/11 terrorist attacks.

For more information on the focus areas of health conditions reported following the disaster, as well as the treatments for those conditions, see the WTC Health Program Research Funding Dashboard. This research dashboard features an interactive tool for all funded projects, lists studies with publications, and includes a bibliography of all research portfolio publications (excluding WTC Health Registry publications).

See Figure 16 for data on the publications resulting from WTC cooperative research agreements.

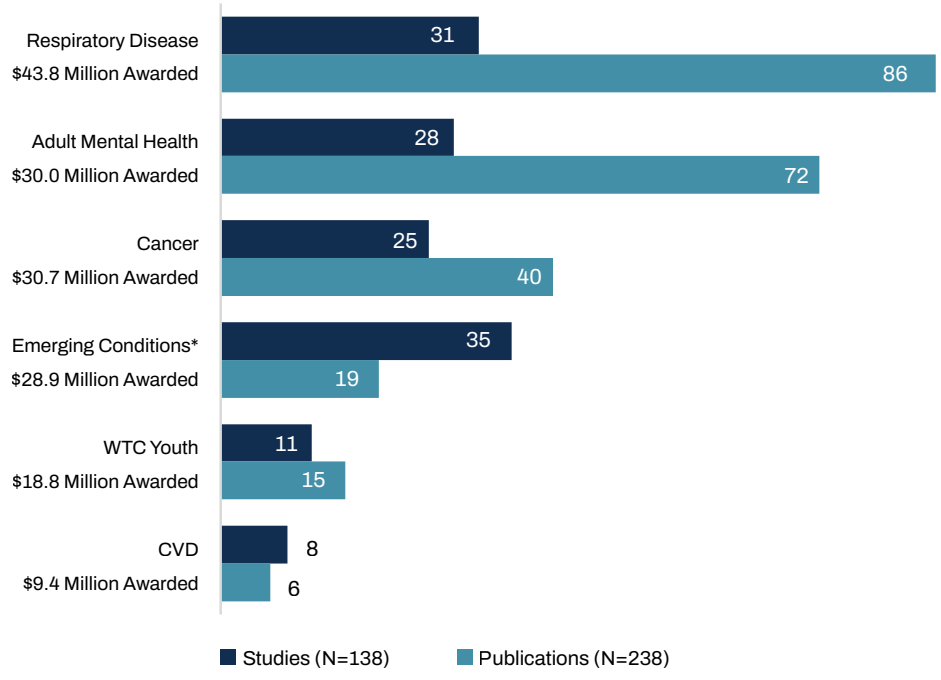


Figure 16. Research studies and publications by primary focus area

Note: *Some projects focus on more than one area, but publications are counted only toward the main area of focus.*

*Emerging conditions: autoimmune disease, assessment of bias in WTC studies, cognitive function, neuropathic symptoms, kidney disease, general responder mortality, WTC exposure assessment-global DNA methylation, trace elements in autopsy tissues from WTC decedents, development of a comparison WTC occupational cohort, and hepatitis C.

WTC HEALTH REGISTRY

Mission and Services

Established in 2002, the WTC Health Registry follows a cohort of 71,431 persons who experienced a range of direct exposures during the September 11, 2001, terrorist attacks and in its aftermath. It is one of the longest running post-disaster registries worldwide. Based in the New York City Department of Health and Mental Hygiene, the WTC Health Registry is an essential public health resource for understanding the long-term (almost 20 years) physical and mental health effects of the September 11, 2001, terrorist attacks.

Data collected and analyzed by the Registry helps WTC responders and survivors, and their clinicians, make informed health decisions. It also helps researchers and policy creators make informed decisions about the 9/11-exposed population. Health resource information is disseminated by Registry staff via multiple channels, including a comprehensive website, annual reports, e-newsletters, brief research summaries, testimonials from responders and survivors, informational videos, social media, targeted mailings, health information sheets, press announcements, and meetings with interested parties and groups.

Communications with registrants are designed to keep them engaged with the Registry for the long term and to obtain registrants' updated contact information. These communications enhance registrants' participation in periodic follow-up health surveys and nested studies to track and understand long-term changes in physical and mental health, quality of life, and gaps in care. Registry staff also helps connect registrants and their families with the WTC Health Program, where they can receive needed healthcare.

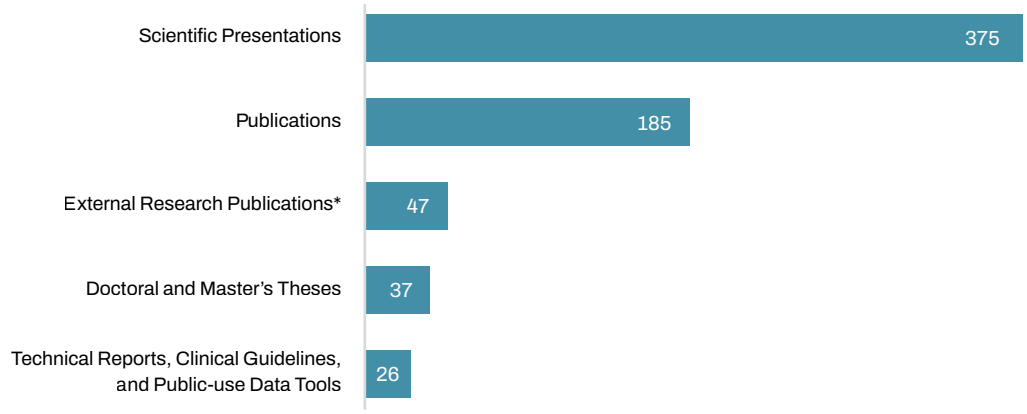
Registry staff works with community, labor, and other partners to keep them informed and to receive input on various research studies, surveys, and other activities related to the 9/11 community. Registry researchers disseminate findings at scientific conferences, meetings, and through peer-reviewed journals. More information can be found at WTC Health Registry.

Enrollment

The Registry enrollment, although now closed, includes 30,664 rescue and recovery workers and 49,732 survivors who lived, worked, attended school, or were present in lower Manhattan on September 11, 2001. Nearly 9,000 registrants are both survivors and rescue and recovery workers. Approximately 2,625 children under the age of 18 at the time of the attacks were registered during 2003–2004; all are now adults 18 years of age or older. As of February 22, 2022, about 1,715 child registrants who aged into adulthood have consented to remain in the Registry as young adults, WTC Health Registry staff are conducting outreach to the remaining unconsented young adults.

Scientific Outputs

From January 2004 through July 2023, the WTC Health Registry had a total of 670 scientific outputs (publications, presentations, published guidelines, etc.). The distribution of outputs by type is presented in Figure 17.



*These are publications resulting from registry-facilitated recruitment into external research studies or registry provided de-identified data.

Figure 17. WTC Health Registry key scientific outputs including publications and presentations, January 2004–July 2023

For summaries of the Registry's annual reports, peer-reviewed scientific publications, registry bibliography list, technical reports, and clinical guidelines, please visit WTC Scientific Bibliography. The listing on this site will be updated periodically by the Registry staff. For Registry highlights and other 9/11 health information, please visit NYC: 9/11 Health.

APPENDIX: FY 2023 NIOSH FUNDING OPPORTUNITY ANNOUNCEMENTS BY MECHANISM

Funding Opportunity	Mechanism	Title
Investigator-initiated Research		
PAR-18-799	K01	Mentored Research Scientist Development Award
PAR-18-812	R01	Occupational Safety and Health Research
PAR-18-797	R03	NIOSH Small Research Program
PAR-21-148	R13	NIOSH Support for Conferences and Scientific Meetings
PAR-18-798	R21	NIOSH Exploratory/Developmental Grant Program
PAR-21-193	U13	NIOSH Support for Conferences and Scientific Meetings
RFA-OH-23-001	R21	Exploratory/Developmental Grants Related to the World Trade Center Health Program
Training Programs and Centers		
RFA-OH-22-006	T03	Commercial Fishing Occupational Safety Training Project Grants
RFA-OH-22-003	T03	Occupational Safety and Health Training Project Grants
RFA-OH-23-003	T42	Occupational Safety and Health Education and Research Centers
Cooperative Agreements		
PAR-20-280	U01	Cooperative Research Agreements Related to the World Trade Center Health Programs
RFA-OH-22-004	U01	World Trade Center Health Research related to World Trade Center Survivors
RFA-OH-22-005	U01	Commercial Fishing Occupational Safety Research Cooperative Agreement
RFA-OH-23-002	U24	Occupational Safety and Health Surveillance Collaboration, Education, and Translation
RFA-OH-22-002	U54	Centers for Agricultural Safety and Health
RFA-OH-20-007	U54	National Center of Excellence for the Prevention of Childhood Agricultural Injury
PAR-21-165	U60	Underground Mine Evacuation Technologies and Human Factors Research
RFA-OH-19-001	U60	National Center for Construction Safety and Health Research and Translation
RFA-OH-23-004	U60	Miner Safety and Health Training Program—Western United States
RFA-OH-23-005	U60	NIOSH Robotics and Intelligent Mining Technology and Workplace Safety Research
Cosponsored Research With the National Institutes of Health		
PA-22-176	R43, R44	PHS 2022- Omnibus Solicitation of the NIH, CDC, and FDA for Small Business Innovation Research Grant Applications
PA-21-259	R43, R44	PHS 2021 Omnibus Solicitation of the NIH, CDC, and FDA for Small Business Innovation Research Grant Applications (Parent SBIR [R43/R44] Clinical Trial Not Allowed)

This page intentionally left blank.

Promoting productive workplaces through safety and health research

DHHS (NIOSH) Publication No. 2026-100